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Introduction.

TO what trait in human nature can we chiefly ascribe England's greatness as a nation? Though the typical Briton may have sporting instincts, may be fond of adventure, may be of an enterprising nature tempered with calm resolution, yet after all is it not that inherent love of mechanics and practical science that has done even more than all to develop those great industries which have brought this country to the forefront?

Though the United States may lay claim to being the land *par excellence* of inventive genius; though France may have pioneered the way in many great devices and brought forward many valuable theories; though Germany, Italy, and other countries may have given birth to many useful appliances and important discoveries, yet it is the land of Newton and Cavendish, of Wheatstone and Faraday, of Stephenson and Nasmyth, of Kelvin, Crookes, and many more, that must be looked upon as the real home of practical science.

And not only is it possible that we may have among us some possessing that latent genius which, if encouraged and brought out, may develop worthy successors to the great roll of British scientists, but we certainly have many who, if they can be induced to take a greater interest in industrial science, to read what others are doing and what may be done, can greatly aid their country by directing their knowledge and energies in more favourable channels. Manufacturers, the mainstays of the Empire—agriculturists, our food suppliers—shipbuilders and sailors, who have hitherto added so much to our greatness—soldiers, on whom we depend for our national safety—and statesmen, too, who rule the country, all may be improved in mind and better able to further the interests of the nation can they but be induced to study more the progress in mechanical applications and discoveries in Nature.

Many of them are unable to spare the time for diving into books or technical periodicals, and learn but little beyond what may come to the surface in the ordinary Press. Yet their interest in these matters should be fostered and encouraged.

In these days of hurry and worry, when business and moneymaking absorb men's thoughts, the perusal of periodical literature has come to be looked upon rather as a pastime than as an intellectual study. With overstrained minds the lightest of reading is in request, to turn the thoughts from the prosaic line of business. Can useful and practical instruction be presented to them in a more attractive form than hitherto, so that they may be induced to peruse and digest it?

Scientific narrations put plainly and fully before us may often be somewhat dull and forbidding to those who are not specialists in that particular line. But when Science decks herself in dainty garb she will often appear attractive and alluring to our weary eyes, and it will be with pleasure that we enter the labyrinths of her mysteries.

Already the literary world may seem to be flooded with periodical publications. But the many opportunities of reading now available and the spread of education calls for more and more. The desire to read on the part of those classes hitherto unable to interest themselves in anything much beyond the gossip of the public-house has now grown keen and absorbing, and a greater supply of literature is needed.

Among this mass are many publications devoted to Scientific subjects. There are those containing deep and technical matter, invaluable to the professional, but uninviting to the outsider who peeps into them and fain would be instructed. There are those confining themselves more or less to one special branch, such as Astronomy, Natural History, or perhaps Engineering and Mechanics. There are papers for the practical workman, and there is lighter literature of a so-called scientific nature, but too often diving into fancy or well-worn truisms.

But we think we see a vista through these cumulations of literary foliage—a space requiring to be filled.

A light and attractive journal, entertaining and amusing as much as really instructing, should have a useful scope among the English-reading public. Plentiful illustrations always add lustre to literature, even as gems adorn a crown. Variety in subject ensures the interest of many, and a vast scope is included among the many branches of Science.

So that in this vista is a site where a tree may take root and grow, drawing from the soil valuable but latent resources, and, spreading forth its branches far and wide, may shoot out its fresh green leaves and fragrant flowers to expose to the air the product of the richness of the land.

Range-Finders.

SOME NEW INVENTIONS FOR MEASURING DISTANCES.

IF only a little instrument could be made which, by a simple observation through it, would enable one to measure at once the distance of any object, how useful it would be! Not only soldiers and surveyors, but travellers, tourists, sportsmen, golfers, and many others would crave for its possession. But, unfortunately, it seems as if such an invention must be classed with those of the ambitious alchemists, since either elaborate complications must be included involving an instrument too costly and bulky to be used on ordinary occasions, or a more or less long base must be measured over the ground, which takes time and trouble.

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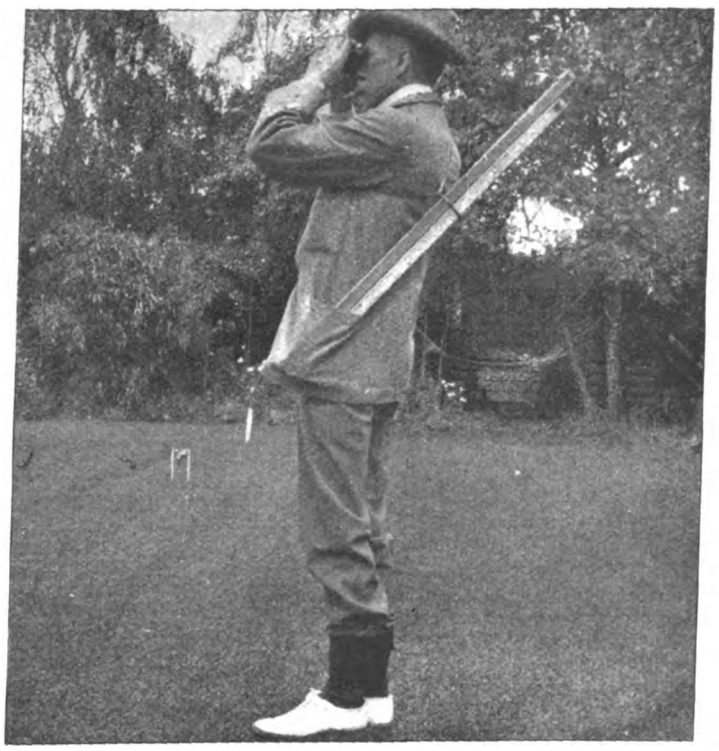
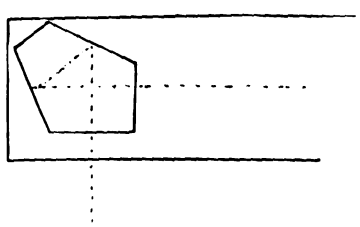
But modern warfare urgently calls for such an appliance, however complicated the design or process. Long-range rifles and guns are of little avail if the distance of the objective be unknown. With a rifle firing up to 3,000 yards, a distance not easy to judge with the unaided eye, an error in the sighting of one-tenth the distance would have a vast effect on the result produced. It would be difficult to estimate whether a party of the enemy was 2,500 or 2,800 yards off; yet if the bullets were dropping 300 yards short of their mark, not much damage would be likely to accrue. In the olden days of weapons only able to send their missiles 400 or 500 yards, the case was very different, for such a distance can be more accurately judged by eye, and the actual effect on the enemy can, as a rule, be better observed. It would seem, then, that some form of range-finder will be well-nigh a necessity in future wars. The "Mekometer," hitherto used in our army, is a somewhat cumbrous apparatus, and proved so unpractical in the recent war that it was seldom used. In our navy, an instrument (invented by Professors Barr and Stroud) with a short fixed base is used. Other range-finders of somewhat similar design have been introduced by Zeiss and by Adie.

The most usual method of ascertaining distances by range-finders has been that of measuring a fixed base line, and observing the angles, one of which is usually a right angle, from each end of that base to the distant object. Another principle, which in reality also depends on the angles subtended at the ends of a fixed base, is that of noting, through a telescope or field glass, the exact height of a man, on a



Professor Forbes's Apparatus packed.

scale arranged inside the instrument, and assuming him to be of average stature his distance can thus be read off. This principle, however, owing to the relative shortness of the base and the uncertainty of its exact length, can never be accurate at the long ranges which it is now desirable to measure in military operations. A third well-known system depends upon the relative velocities of sound and light, and by carefully noting the time occupied between the flash of a gun being observed and the report of its reaching the ear, a good idea can be obtained of the distance the gun is off. But this can but seldom be applied in practice, since the flash of a gun is not easy to see, and many reports may be heard about the same time. An instrument called the "acoustic telemeter," based on a principle different



from any hitherto utilized in range-finders, has been undergoing trials in Italy. General Giletta, of the Italian army, hopes to obtain accurate results by the sound alone of a gun, his instrument being affected more or less according to the disturbance of the sound waves. At first sight this may appear a very uncertain method of accomplishing the object, since not only the distance, but the charge used should influence the result. With many guns of different calibres and different powder-charges, confusion may well be caused, while it would also appear probable that wind and other atmospheric disturbances would have confusing effect. There is, however, another most useful purpose to which, in the inventor's opinion, this particular instrument may be put. In modern warfare, with smokeless powder, the very great difficulty of ascertaining the position of the enemy's guns is well known. Unless the eye happens to be fixed in the right direction, the flash, even, is unnoticeable, while the gun itself, especially if behind some cover, is quite beyond the range of unaided vision at three or four miles off. This new instrument is so arranged as to show the exact direction from which a sound emanates, though here, again, one would have thought that wind would affect the accuracy of the instrument.

One of the latest and most practical-looking of the "fixed base" range-finders is that of Professor George Forbes, an improvement on Adie's apparatus. In this there is an aluminium or steel rod, six feet

The Range-Finder in Action.

long (capable of being folded in two for portability), at each end of which is a prism. The distant object is thus reflected from the ends of the base to the centre, where other prisms reflect the object through a binocular telescope to the eyes of the observer. The prisms used are double-reflecting, as shown in the accompanying cut. This arrangement has the advantage that absolute rigidity in the base is not important, as it would be if only a single reflection at each end were used, and consequently the hinge can be introduced. The angles are measured by two vertical wires, one in each telescope, moved by a micrometer screw until the two wires appear as one. The inventor lays great faith in this effect of stereoscopic vision, believing it to add greatly to the accuracy of the instrument (though opinions on this point would appear to vary). This instrument should form a most handy and practical apparatus. The base rods weigh 2½ lbs., the binoculars (magnifying 12 diameters) 1 lb. It has been tried under many conditions, not only at home, but actually under fire in South Africa. Its accuracy is stated to be such that there should be no error greater than 60 yards (or 2 per cent.) in 3,000 yards.

Two practical objections may be brought against this instrument. First, that extreme nicety of adjustment is absolutely necessary, so that any incidental damage to the metal rods or delicate wires, such as is very likely to occur on active service, may prove fatal to its use, and secondly, that the price is such as to put it beyond the reach of the ordinary private individual. It is also somewhat bulky to carry about.

Another recently-introduced instrument possesses qualities exactly overcoming the objections above referred to, for the "Simplex range-finder" is so extremely simple in construction that, short of a waggon going over it, it is difficult to see how it could be so damaged as to render it inefficient; its price is considerably less than that of any other range-finder, and it is so small and compact that it easily goes in the waistcoat pocket. This apparatus depends, however, on a more complicated system of observation, since first an observation has to be made to find the direction of the base, the latter has then to be paced until the second angle is found, when the base will be one-tenth of the range. The principle is very similar to that of the well-known Weldon range-finder. Some doubt has been cast upon the exact accuracy of the measurements of so simply-formed an instrument, but after all, for musketry purposes in the field, extreme accuracy is not of importance, since the rifle itself may easily be inaccurately sighted, and wind and other atmospheric effects may cause the bullet to fall 30 or 40 yards short or beyond the mark. So that for all practical purposes it is sufficient if we can rely on the range being found within, say, 50 yards of the reality. Another advantage of this system is that a long range can (though it may take longer to do) be measured with the same percentage of accuracy as a shorter one. With a fixed base, the further the object the greater is the error of measurement likely to be. The distance which can be ascertained by this little instrument is therefore unlimited, and if only a long enough base be used (which can in turn be measured by the range-finder) distances up to several miles can be determined, which should render it most useful for many purposes other than that of measuring ranges for musketry.

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Liquid Fuel for Ships.

Those who have had to undergo the discomfort of sleeping, or trying to sleep, through a night on board a ship taking in coal, will at once appreciate the great desirability of for ever abandoning the custom of throwing those dusty, noisy, friable lumps of mineral into the bunkers. But if a mere passenger feels so disconcerted in one night, what must be the sensations of the stokers, who, day after day, have to be handling and shovelling the dirty stuff? Apart from all question of economy, the introduction of oil fuel would certainly come as a boon and a blessing to the seaman, and there now seems to be some reasonable probability that it will be practically adopted on a good many steamboats.

The Shell Transport and Trading Company, Limited, have set to work in a most energetic manner, to introduce oil fuel on a commercial scale. They now own some 20 steamers fitted for using liquid fuel, each to carry a store of from 4,500 to 11,000 tons. The oil is brought from Burma and from Texas, and taken to various "coaling" stations. In the Thames is one capable of storing 30,000 tons.

The question of the existence of a sufficient supply of oil, supposing all ships took to it, will occur to most people as the first item to be decided; but we are assured that there is not much need for anxiety on this score. The Shell Company alone tap fields from which 100,000 tons a day can be got. When it is considered that a good large steamer only consumes about 18 or 20 tons a day, it will be seen that it would be possible, even now, to supply fully 5,000 vessels. The Company owns 41 storage stations in various parts of the world, having a total capacity of 285,000 tons.

In Burma the principal distributing station is at Balak Koetei, where storage is provided for 72,000 tons. The oil-fields here are said to be capable of supplying all the oil required in the world. In Texas the fields are close to the sea, and their capacity is proved to be about 20,000 tons a day. Both these sources of supply are actually situated in the Eastern and Western hemispheres.

Besides Burma and Texas, large fields exist in Southern Russia, in Roumania, Borneo, Java, and probably in many more places where it has not yet been exploited.

If, then, the supply of this most desirable commodity be sufficient, there is only the question of economy. This is a matter somewhat difficult to decide with certainty. The actual price must, of course, depend on the distance to which the oil has to be brought from the fields of supply. In London it can be delivered at 35s. per ton, but in New York it costs 25s., in New Orleans only 20s. per ton. As coal also varies greatly in price, comparison between the two cannot be very exactly determined. One of the steamers of the Company, the *Clam*, after running for six years burning coal at the rate of 26 to 28 tons a day, has, for over two years, been burning nothing but oil-fuel, of which she consumes an average of 18 tons per diem. From these statements it would appear that only two-thirds the weight of oil is required for an equivalent of coal.

There are also several facts which render the oil-fuel more economical than coal. Compactness of transport confers an advantage. It has been calculated that the space occupied by oil compared to the equivalent amount of coal is as 35 to 90. Thus much space is gained for cargo. The shape and position of the bunkers would also be immaterial, so that on board ship it can be stored in any form of tank, not necessarily near the boilers, and conveyed by pipes right to the furnace. Then, odd and awkward spaces are utilized which would be quite unsuitable as coal bunkers. The deterioration of coal exposed to the air, especially in hot climates, is also an item to take into consideration.

The theoretical efficiency of oil-fuel is stated as that 15 lbs. to 16 lbs. of water can be converted into steam per pound of oil consumed, whereas coal only evaporates about 9 lbs.

Another very important point regarding the economy of liquid fuel is the comparative ease of "stoking" or supplying the fuel to the fire. A very greatly-reduced force of men would be required in the stoke-hole. Not only does this imply a reduction in the wages list, but the great difficulty at present existing, of obtaining good capable stokers, is minimised. The oil burners are almost automatic in their action, and require very little attention. It is said that of 160 stokers, as often employed on a liner, only 20 would be needed to look after the liquid fuel apparatus, while the work itself would be infinitely more congenial than the labour of perpetually shovelling coal.

The increased cleanliness all over the ship by the abolition of smoke would also play a considerable part in its economical working.

The use of liquid fuel in warships, where economy is not, or should not be, of such moment, is a subject of still more importance. Ease of getting the fuel on board, and compactness of storage are great considerations. But smokelessness of combustion is still more desirable, for the most usual way of detecting the approach of a steamer when at a distance is by the cloud of smoke which usually hangs over her. In war it would often be of the greatest consequence to be able to approach as near as possible unseen.

Experiments were commenced in our Navy in 1898 on board the *Surly* at Portsmouth, and since then the *Blonde* has been fitted to try liquid fuel. The second-class cruiser *Arrogant* is now also arranged to test it.

Lieut. Winchall, of the United States Navy, in his report to the Navy Department, gives details of working of oil fuel on the steamer *Mariposa*, on a voyage from San Francisco to Tahiti. The daily consumption was about 278 barrels of oil, and the horse power developed 2,481. The weight of liquid fuel consumed was about 50 per cent. less than that of the coal which would have been burnt under similar circumstances. Twenty stokers were employed in place of 36 as usually taken.

In the Russian Navy more has been done, since the plentiful supplies of oil on the shores of the Caspian Sea, have for long caused this form of fuel to be much used on steamers in that locality. The turret ship *Rostilav*, of the Black Sea Fleet, is regularly fitted for the consumption of liquid fuel.

The oil used for these purposes is the residue left after the lighter constituents, benzine, paraffin, etc., have been removed. It is then not volatile, nor does it readily give off inflammable gas, as does petroleum.

The combustion is affected by forcing the oil into a fine spray, when it burns almost as gas. A jet of steam drives the oil forward with great force, and mingling with it, discharges a mass of burning vapour into the furnace, where it impinges on a fire-brick screen.

It would then appear that we now have a fuel suitable for steamship use, which certainly appears to be more economical than coal, which, for present supplies at all events, is plentiful, and which possesses so many great conveniences over mineral fuel that we certainly expect, and hope, to see it largely adopted in years to come.

Improved Mechanical Computator.

The United States Government is constructing a new machine for working out the highly complex calculations which occur in tidal problems. The plan for this machine was made by E. Terrel, who is employed on the United States Coast Survey. If the inventor has improved on Kelvin's mechanical computator, now used in America, he certainly deserves credit. The machine in question, which is not very much larger than the ordinary typewriter, is one of the cleverest and speediest of computators; unlike the mathematician of flesh and blood, it is incapable of making mistakes. There is a small crank on the lower left-hand side, and a single turn of it gives the answer to a "sum" involving no less than nineteen computations

Curious Preparation of Potato Pulp.

Not many years since, the threatened ivory famine produced that remarkable preparation known as celluloid, which has been successfully employed for every possible use. To-day the imitation has itself been imitated, and that, too, by a curious preparation of potato pulp! The inventor is a Dutchman named Knipers. He treats the waste pulp, itself a residue from the manufacture of the artificial potato flour, with a solution of acid and glycerine. The resulting compound takes the form of a kind of stickfast, which is dried and ground to powder. This powder is moulded into blocks with the aid of water, very much as one uses plaster of Paris. There is, however, this important difference. The new compound can be cut and turned, and bored, and used for every purpose, from buttons upwards, in which it was customary to use bone and ivory.

Osmium Lamps.

A year or two ago Dr. Auer von Welsbach, whose name is so well known in connection with lighting, succeeded in obtaining osmium, which has the highest melting point of all metals, in a filamentous condition. He found that it was a good conductor and could be applied with advantage instead of carbon in incandescent electric lamps, as it is more durable and capable of withstanding a higher temperature. Osmium lamps have been constructed for tensions of 25-50 volts, and if these were used with the current as usually supplied at 100 to 200 volts it would be necessary to couple several in rows or insert a transformer. Experiments have since been made to test the relative efficiency of these lamps with ordinary carbon lamps. In one test four 25-volt osmium lamps in series and four 100-volt carbon lamps in parallel were arranged on a 100-volt circuit, and both gave the same illuminating power, but the osmium lamps consumed only 40 per cent. of the current required for the ordinary lamp. In another test an osmium lamp consuming energy equal to twenty-four watts gave a light of twenty-candle power, while a carbon lamp with the same consumption gave a light of only six-candle power. Osmium lamps can be made to give a light of from two to two hundred candles, and lamps that have become darkened can be restored without renewing either the bulb or the filament. It would be interesting to know how far the price of the metal would be prohibitive, as the supply is limited, and the demand for it in making X-ray tubes has lately increased.

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A New Method of Inflating Balloons.

One of the principal reasons why balloons are not more often used for pleasure trips and other purposes is because of the expense and difficulty of inflation. For military purposes also the transport of the gas or the apparatus for making it is one of the greatest difficulties to be contended with.

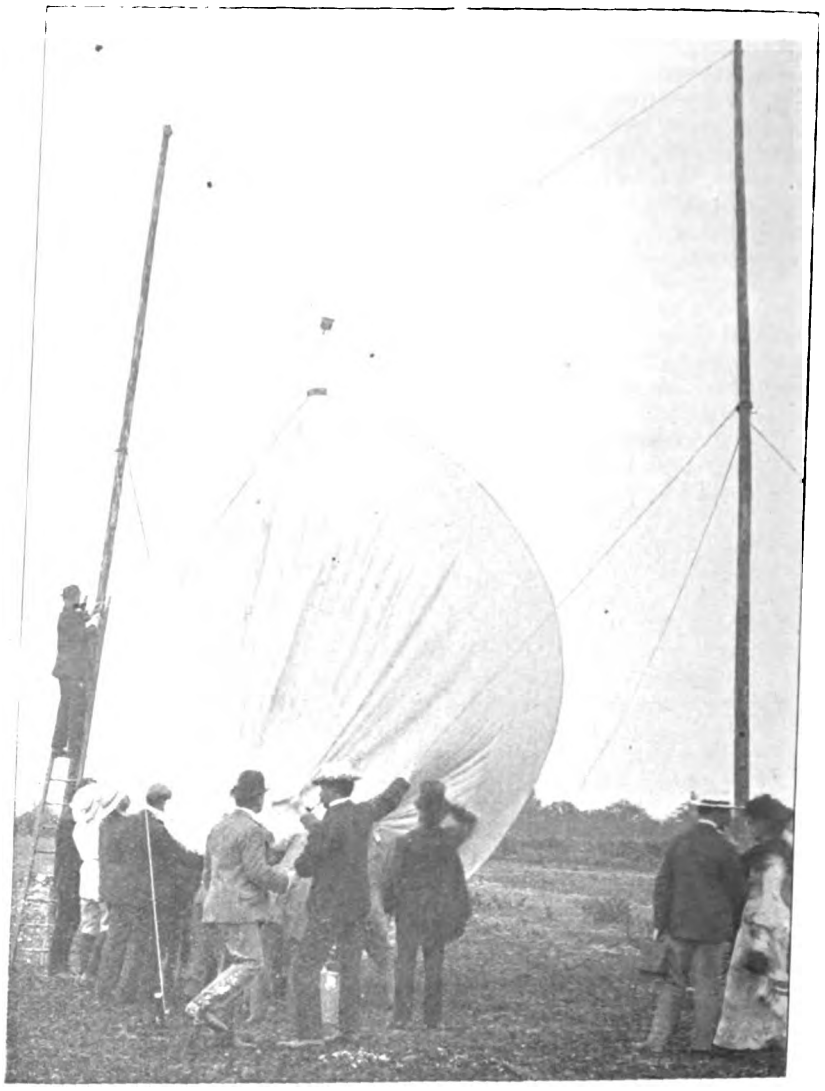
There are three practical methods of causing a balloon to ascend. The first ever tried, and the simplest, is that of heating the air contained within it to such a degree as to render it sufficiently light to lift the apparatus, or in other words, to so expand the air by heat that a lesser weight of it fills the same space. This was the principle used by Montgolfier when, in 1783, he endeavoured (and with some success), to make "an artificial cloud" by enclosing a mass of smoke in a large paper bag.

The second method, introduced by a Frenchman named Charles very shortly after, is to inflate the balloon with hydrogen gas, which, weighing but one-fourteenth the weight of air, is able to lift a good load into mid-air. The third system, first utilized by the aeronaut Green, is to substitute ordinary coal-gas for hydrogen, the former being cheaper and more readily procurable.

Mr. Maskelyne with Filling Apparatus.

All these three methods are frequently used, each being suitable to its particular purpose. The hot-air principle is most employed when it is merely required to rise to a height in the air without remaining long there. Thus, for the exhibition of parachute descents it is often used. In some of the earliest balloons a store of fuel was carried so that the machine could be kept floating in the air for a considerable period. But the fuel used was bulky and heavy, necessitating a very large balloon to carry it, and chopped straw, which was found to be the most suitable form of fuel, was apt to give off sparks which easily ignited the flimsy fabric. But to light a large fire under the balloon on the ground, and, when the air within it is thoroughly heated, to let it ascend and remain aloft until the air cools, is comparatively simple and easy.

Suggestions have been put forward at various times regarding the possibility of carrying up a stove burning some hydrocarbon with a powerful flame, but hitherto no such system has been found to answer in practice. Mr. Maskelyne, the well-known and clever entertainer, of the Egyptian Hall, has thought of applying, for this purpose, the apparatus known as the "Wells light." This, it may be explained for the benefit of those unfamiliar with it, consists of a tank of paraffin, to which is attached a small hand-pump, by means of which an air pressure of some 20 lbs. is brought to bear on the liquid. The paraffin is thus forced along a pipe to the burner, which consists of a series of tubes, so arranged that, when heated, the oil within them becomes volatilized and issues from a nozzle as a jet of gas under pressure. This, mixed with a due amount of air, on the Bunsen burner principle, is lighted and gives forth a very powerful flame.



Inflation in a Wind.

Experiments have been conducted on several different occasions during the past month with this combination, Mr. Maskelyne having been assisted by the Rev. J. M. Bacon, the well-known aeronaut. A model balloon, but so large a model as to contain 2,000 cubic feet.

Inflation complete.

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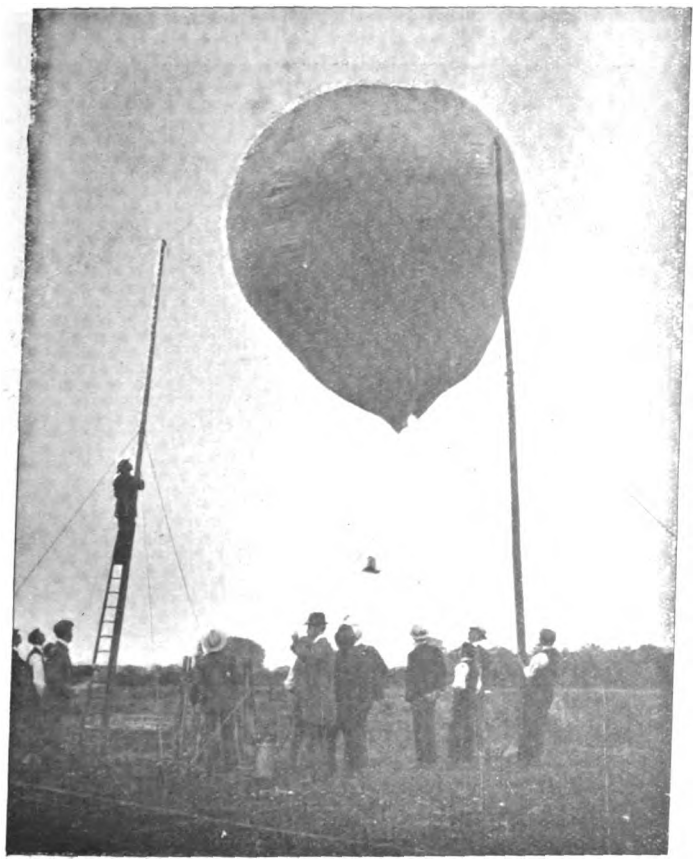
was used, and it is surprising how rapidly this could be inflated. From one minute to a minute and a half is all that is required to bring about the desired effect. This rapidity of inflation, if it be found to apply equally well on a larger scale, confers further benefits on the system, because it enables a balloon to be filled during the lulls on a windy day, which is so extremely difficult under ordinary circumstances.

In these trials, however, the lamp and fuel were not carried up with the balloon, though it is merely a matter of calculation to find out how much such a volume of hot air will lift, and how much the heating apparatus weighs. In this case a large, ready-made lamp was used, probably sufficiently powerful to heat a much larger balloon, and certainly could be made much lighter in weight. Such a hot-air balloon should, in practice, lift about 60 lbs., and the weight of the lamp and tank complete is actually not much more than this. This lamp consumes about two gallons per hour of paraffin, so that a supply to last some hours could probably be carried.



Balloon Ascending.

The photographs reproduced herewith show clearly the various stages of the operation of inflation. The first shows Mr. Maskelyne holding in his hand a photographic camera, which is to be sent up with the balloon. To his left is the chimney, of light sheet-iron, covering the stove, which is in a small excavation in the ground. This is surrounded by some stakes to prevent the fabric of the balloon being scorched. Nearer, and to the right, is the oil-tank and a fresh supply of paraffin. The next picture represents the balloon, half inflated, surging about in a strong wind, supported by the two poles and held closely over the stove by the assistants. The third photograph shows the machine fully distended and ready to ascend; while, in the fourth, the balloon is actually rising into the air with the camera hanging beneath it.

Oxygen.

It is 127 years since Joseph Priestley discovered oxygen. He called it Dephlogisticated air, Scheele, who separated it about the same time, Empyreal air; while Condorcet, more happily then either, suggested vital air. Lavoisier named it Oxygen, literally, the acid maker, and in so doing he perpetuated an error. It is not oxygen that is the essential element in the formation of acids, but hydrogen, so called because it helps to form water. The early chemists would have hit the mark better if they had interchanged the designations; for oxygen constitutes the great bulk of water, and hydrogen is a constituent of all the acids. What's in a name in this case is a chemical misrepresentation. Priestley little knew how wide was the range of the element he had found. Oxygen forms one-fifth of the atmosphere, eight-ninths of the waters, and, taking all together, one-half of all the materials of the globe, so far as they are known. As carbon is the basis of all the organic substance of the world, so oxygen, the supporter of life and combustion, represents its living energies.

The Preservation of Flowers.

A Simple Method of Rendering Botanical Specimens Everlasting.

A new and simple process of preserving flowers, and, indeed, all botanical specimens, has just been brought into prominence. It seems remarkable that such an easily-applied method has not long been in use for rendering the beauties of the plant world more permanent, but if it has been known, it has certainly not hitherto been much utilized.

The method of pressing flowers between leaves of a book or specially arranged papers, though simple, and making the specimens compact, and, when mounted, easy to keep in convenient form in an album, yet is open to the great objection that the specimens are distorted out of shape, and the natural appearance of the plant is often entirely lost. Moreover, with many objects, such as a rose or other large flower, this method is impossible to apply. By the new process the shape and form of the living specimens are preserved, and a flower so prepared, if carefully done, can scarcely be told from a freshly-cut specimen. Some flowers are, of course, more difficult to deal with than others, but with care almost all kinds of plants can be made everlasting.

The process merely consists of covering the flower or plant with a very fine sand. The principle is, in fact, the same as that by which so many interesting relics have been preserved for ages at Pompeii and Herculaneum. The sand, which must be perfectly dry, and quite free from any colouring matter, is contained in a sort of colander or pepper box, and is gradually sprinkled over the specimens (which must also be thoroughly dry) lying in a box or other vessel. The latter has to be continually tapped all the while to ensure the sand sinking in between the interstices and hollows. Care has to be taken that the leaves and petals are not weighed down by the weight of the sand and so drawn out of shape. The shower of fine dry dust continues until gradually the specimens become entirely buried, and still the stream of sand goes on, until a depth of several inches lies over the specimens, so as to ensure a certain amount of pressure. Then the box is put carefully away and must not be disturbed for several days. The time taken will depend upon the nature of the plant. If large-leaved and containing much moisture, it will take longer than if small and thin in structure. Six or eight days, however, are usually sufficient for the specimens to become dry and fixed, and the sand is then gradually and carefully removed. It is almost surprising to note how the appearance of the plants will have scarcely altered in the least since they were put in, and yet they will now be found to be dry and stiff, and will so remain, perhaps, for ever, if kept free from damp. But to avoid this deterioration from dampness, as well as to give a certain gloss which is generally lost in the process of sand compression, the specimens must now be coated with a preparation of varnish. This is best made by dissolving shellac in a hot solution of carbonate of soda or ammonia, forming a very thin varnish, in which the plants are dipped and shaken nearly dry, when a fine hard coating of shellac is formed, which completes the preserving process.

Purity of Air.

Dr. Symes Thompson gave some Fresh Air statistics at the Congress on Tuberculosis which showed that, even with a window wide open, the air of a room was not so pure as that outside. Consumptive patients, it was found, did better sleeping on a balcony than in the best-aired chamber, the reason being that there is not enough movement of the air in the latter case. As the doctor said, we create an atmosphere around us which in the open—and nowhere else—is every moment being renewed. The variation between the two conditions may be a small percentage of carbonic acid and organic matter, but it is enough to make all the difference between buoyant health and depression.

Electricity *v.* Fuel.

The town of Davos is considering a bold scheme for the abolition of all the ordinary forms of fuel. It is proposed to erect an extensive electric plant at the confluence of two large mountain torrents, whose united waters will supply the necessary motive force. A large firm of Swiss electricians has been studying the problem for over a year, and has obtained the concession of the forces of the torrents alluded to. The same firm has brought out some new electric heating and cooking apparatus, specially designed for the scheme. The first cost of the installation is estimated to be eight and a half million francs. Already electricity is not only used for lighting and motive power, but is adopted in many villas for cooking and heating, and in one of the largest bakeries. The idea is to do away with all contamination of the air by the use of fuel.

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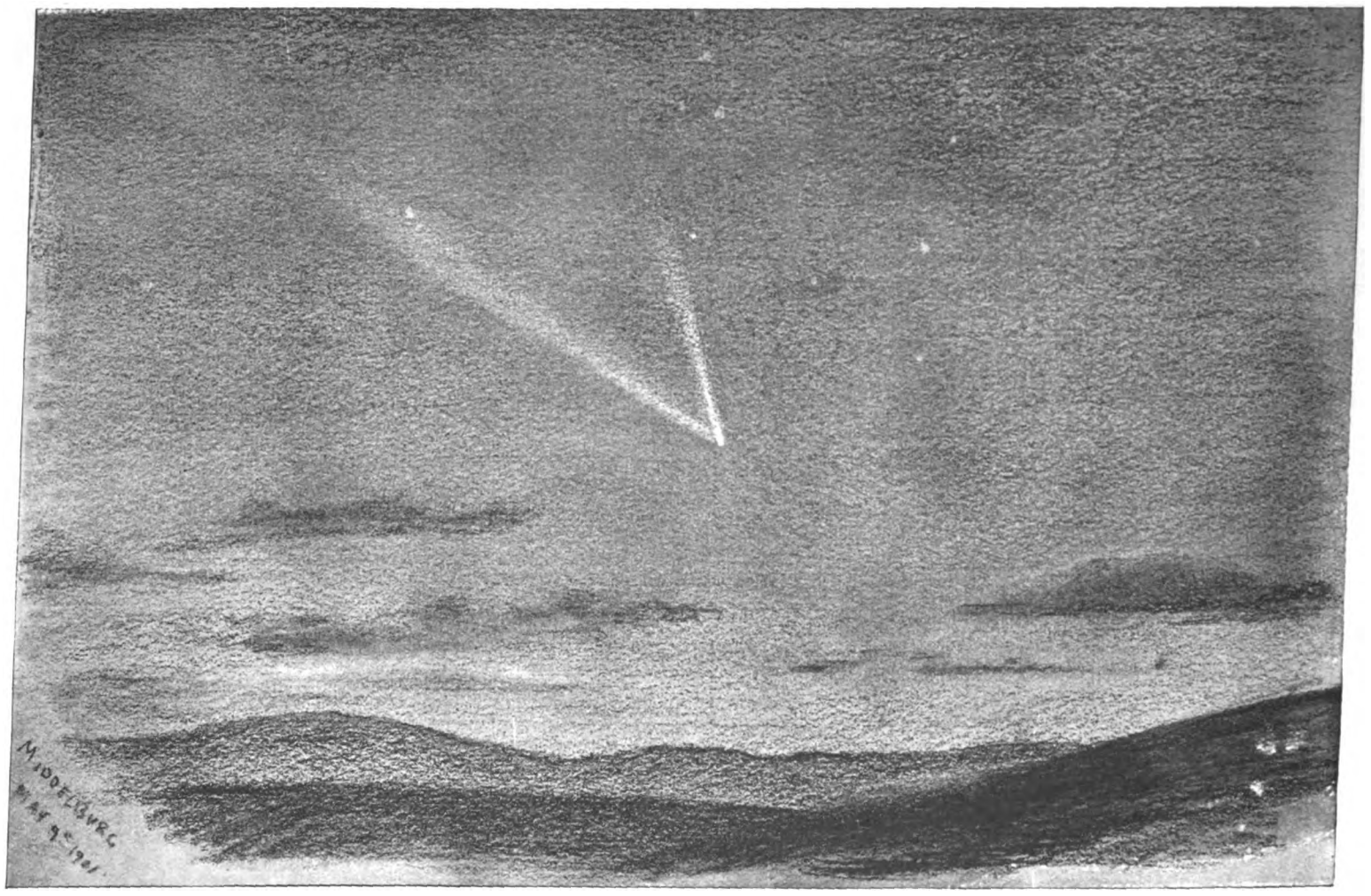
The Great Comet of 1901.

With the approach of another comet, which should attain its greatest brightness about the 9th of October, interest is awakened in these mysterious heavenly bodies. The present visitor is not likely to become a conspicuous object in the sky, though it may be visible to the naked eye, passing the constellation of Cygnus in the early part of the month.

Although it is now possible to photograph the tail of a comet, there is still a considerable interest in carefully-drawn sketches of their appearance. As but few representations of the great comet which visited us last year have been published, we produce one, drawn by a careful observer in the Transvaal on May 9. The relative proportions are put down as accurately as possible, and a very good idea of the size of the comet may be gathered from the constellation of Orion, which is here seen immediately above it, the star to the left hand of the picture in the longer tail being Rigul. Prof. Bredikhine, who has investigated the subject, considers that the tail of a comet, that is, the particles of matter surrounding it, are *electrically* repelled by the sun, or are at all events not attracted by gravity as is the nucleus. This theory, which is not wholly new, would explain the fact of a comet's tail always pointing away from the sun. The lightest particles are then most repelled, and the long, straight tails would seem to be formed of light gas such as hydrogen, while the heavier elements form the short, curved tails.



The Comet as seen in the Transvaal.

Snow on the Moon.

According to a recent despatch from New York the existence of snow on the moon has been established by a careful study of photographs taken in Jamaica under favourable atmospheric conditions by Professor Pickering, of Harvard. Particular objects of observation appear in these photographs under sunlight falling at five different angles of incidence, and it would seem that the presence of white patches in the deep valleys and on the high mountains of the moon is evident from a critical consideration of certain localities as the photographs show them at different times of the long lunar day. But there is no reason to believe that these patches consist of snow or water, as the despatch in question suggests, or of frozen carbonic acid, which is thought by some to form the snowcaps of Mars. Deposits of salt, the dregs of long vanished seas, or masses of white volcanic ash unstirred by any wind—for the moon has no atmosphere—might account for the snowlike appearance both in the depressions and on the heights.

How Electricity Affects Growing Plants.

Some very interesting studies have been made from time to time proving that electrical discharge undoubtedly has a considerable effect on the growth of plants. Dr. Lemstrom, of the Helsingfors University, has for a long period been conducting experiments to test this effect. Four seeds of barley, wheat, and rye, were sown in pots, the soil being connected, electrically, with the ground. Above the pots were suspended an insulated network of wire with a number of points. A Holz machine was so connected up that, in some of the pots an electric current passed from the metal network to the earth, and in others it passed in a reverse direction. For five hours daily the electricity was caused to pass through the soil, which was, of course, kept damp. After about eight weeks, the height of the plants affected by the electric current was found to be 40 per cent. greater than of those to which no current was applied. Experiments on other plants showed the same results, but in different proportions. Turnips increased 107.2 per cent., potatoes 76.2 per cent., mangold wurzel 65.3 per cent., radishes 59.1 per cent., parsnips 54.5 per cent., leeks 42.1 per cent., and cabbages 43.6 per cent. Strawberries were found to ripen much quicker under such a process, 26 to 33 days being required, as against 54 days for plants in ordinary conditions.

Liquid Air and Liquid Oxygen as Explosives.

When Professor Dewar's researches at low temperatures first took hold of the popular imagination, certain highly-coloured accounts appeared of the possibility of using liquid air or liquid oxygen as explosives—the notion being that the sudden conversion of gases from the liquid into the gaseous form would result at the moment of expansion in an enormous increase of pressure. Such ideas were in the main founded on ignorance of the properties of liquid gases; but it has been found possible by mixing liquid oxygen and liquid air with carbon to obtain a field of practical usefulness for them. The range of usefulness is limited, but a recent account of the cutting of the Simplon Tunnel mentions that in the explosion of blasting charges, liquid air or oxygen has been used with good effect. The charcoal covering of the charge is, shortly before use, steeped in liquid oxygen, and the recovery of the gaseous form has the advantage of mitigating some of the evils the presence of the carbonic oxide tends to produce. Further experiments are projected with a view to making the combustion more perfect, and removing some of the noxious vapours due to blasting.

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The Purification of Water.

A Simple Remedy Against Typhoid.

The alarming outbreak of enteric fever in South Africa among our troops induced Dr. Rideal (as explained in his Cantor Lecture before the Society of Arts) in conjunction with Dr. Parkes, to specially study the effect of dilute acids when added to drinking waters infected with typhoid. Filters and apparatus for boiling water are undoubtedly most unpractical appliances to carry on service with a rapidly-moving column, and the question to be decided was whether some acid material could not be found which would destroy the virulence or inhibit the growth of the *Bacillus typhosus*, whilst not rendering the water unpalatable or injurious to the health of the consumer.

Sterilisation by Acids.

Long before there was any evidence as to the germ theory of disease, the mineral acids had a high reputation as remedial agents. Nitric acid, for example, was used in 1780 by Dr. J. C. Smith for fumigation during a violent outbreak of typhoid in the British Fleet. (Rideal, "Disinfection," p. 87). Acid fumigation with hydrochloric acid was introduced by Guyton de Morveau in 1805, and both these acids and sulphuric acid have been included in Pharmacopœias as internal remedies for a very long period. Even in the Middle Ages, it was suggested that putrid waters might be revived with "oil of sulphur" or *aqua vitæ* (*fortis*?). Koch was the first to announce that the cholera bacillus was affected by acids. Stutzer found that a solution of .05 per cent. sulphuric acid was fatal to cholera bacilli in fifteen minutes, and showed that 100 kilos of 60° Baume sulphuric acid would disinfect 40,000 litres of water at a cost of less than 1d. per 100 gallons of water treated. It was subsequently proved by Dr. Ivanoff that .40 per cent. of this acid was fatal to cholera bacilli in Berlin sewage, and Kitasato showed that this acid, and also hydrochloric, destroyed cholera germs in a few hours.

The organic acids, like tartaric, citric, and acetic, also possess this property; and in 1893, the use of tartaric acid for purifying water, in conjunction with a filter, was patented, and its use has recently been suggested in Italy for sterilising salads before consumption. Dr. Christmas, in 1892, showed that citric acid, although fatal to the cholera bacillus when used in the proportion of 8 parts in 10,000, did not destroy the bacillus of typhoid in a less strength than 1 in 1,000. It may be that lemon juice and vinegar, as dietetic adjuncts in salads and uncooked shell fish, have further been extremely useful in minimising the dangers of typhoid derived from such sources.

In Dr. Rideal's experiments it was further decided that, to be of practical use, the re-agent should be rapid in its action, and from 15 to 30 minutes was fixed as the maximum time which in practice could be allowed. It was evident that for transport a solid, preferably in the form of tablets, would be the most suitable form. The following experiments show that sodium bisulphate fulfilled all the requirements:—

Series I.—750 c.c. of tap water infected with one drop of a twenty-four hour broth culture at 37oC. of *B. typhosus* (J. 1).

Agar plate cultures made with 1 c.c. of mixture, and colonies counted after 48 hours' incubation at 37 C.	Results obtained after contact of infected water with acid solution for periods of:— 5 mins.	15 mins.	45 mins.	24 hours
Sodium Bisulphate:—				
1 grm. per pint of infected water.....	B. typh. killed	Sterile	..	..
½ grm. do.	..	Marked reduction	B. typh. killed	..
¼ grm. do.	..	..	No reduction	..
Tartaric Acid:—				
20 grains per pt. of infected water....	..	Sterile	..	..
10 grains do. (A)	Marked reduction	3 colonies	..	..
10 grains do. (B)	..	B. typh. killed	Sterile	..
5 grains do.	..	..	No reduction	1 col.
Citric Acid:—				
20 grains per pt. of infected water....	..	Sterile	..	..
10 grains do.	Slight reduction	30 cols.	..	..
5 grains do.	..	..	..	No reduction
Nitro-hydrochloric Acid, B.P. dilute:—				
20 minims per pt. of infected water* ..	..	Sterile	..	..
5 minims do.	..	..	..	No reduction
Sulphuric Acid, B. P. dilute:—				
20 minims per pt. of infected water....	..	Reduction	B. typh. killed	..
5 minims do.	..	..	..	No reduction

* The acidity of this solution is equal to 4·8 c.c. N/1 Na OH per litre and the corresponding H_2SO_4 solution 5·8.

Subsequent experiments show the superiority of sodium bisulphate over tartaric acid.

From the next series of experiments we gather that when a water is infected by a culture of *B. typhosus*, sodium bisulphate (one gramme per pint of infected water) is then only effective if contact has been made for forty-five minutes. Tartaric and sulphuric acids in similar strengths did not so quickly prevent the subsequent growth of the bacillus.

In the case of tartaric, citric, and nitro-hydrochloric acids, it does not appear that anything less than the maximum B.P. dose per pint of water is efficient to sterilise, if the contact is not to last longer than 15 minutes. Half the maximum dose (10 grains) per pint is inefficient in the case of citric and tartaric acids after 15 minutes' contact, whilst the minimum dose (5 grains) per pint of citric acid has no effect after 24 hours' contact; and in the case of tartaric acid the minimum dose did not completely sterilise after the same period. Of the two, tartaric acid appears to be the most potent in its destructive action upon *B. typhosus*.

The pint has been taken as a standard, as this is the quantity of water which a man might be expected to drink off at once: one gramme to the pint is equivalent to 1 in 568.

Nitro-hydrochloric appears to be more efficient than sulphuric; but no further experiments were made with these, as it was considered essential that the substance to be carried by individual soldiers in the field should be a solid, and not a liquid.

Acid sodium sulphate is not a B.P. medicinal substance. It probably has no purgative effect, as the astringent properties of its free sulphuric acid would tend to counteract any laxative action of the sodium sulphate. The minimum purgative dose of sodium sulphate is a quarter of an ounce, and in the use of 15 grains per pint of water, a man would have to drink seven pints before a quarter of an ounce of a salt, not known to be purgative, would be taken. Even if this quantity of water was drunk in a day, there is no evidence that a quarter of an ounce of the bisulphate would exert any harmful effect.

Series I. shows that the *B. typhosus* is killed by only five minutes' contact with solution bisulphate in the proportion of one gramme per pint of infected water; but fifteen minutes gives additional security.

As regards acidity, the same amount of acid, as measured by decinormal soda solution, appears to be required to produce a similar result in nitro-hydrochloric acid (dilute B.P.), and sulphuric acid dilute P.) while sodium bisulphate in the proportion of one gramme to the pint contains about two and a half times the acidity of 20 minims of sulphuric acid (dilute B.P.). If anything, the nitro-hydrochloric acid appears to be the most efficient *quâ* acidity; and this is intelligible when it is recollected that there is likely to be a small quantity of free chlorine in this acid. The citric and tartaric acids, to be efficient, must contain at least three times the amount of acid, as measured by decinormal soda solution, that is sufficient for nitro-hydrochloric and sulphuric acids.

Series IV.—500 c.c. of boiled tap water infected with one drop of a twenty-four hour broth culture of *B. typhosus*. Cultures from four different sources were used, marked respectively J 1, R, B, and M, thus making four infected waters. The one marked J 1 was found to contain 9,120 cols. of *B. typhosus* per 1 c.c.

This series is especially interesting, as it shows that different breeds of the typhoid organism are practically identical in their behaviour. I have since repeated these tests with the same organisms, after sub-culturing for some months in the laboratory, and obtained almost identical results, thus showing what I believe has hitherto not been established, that sub-culturing outside the human body for a long period, as might occur in natural waters, does not sensibly alter the susceptibility of this organism to chemical reagents.

A further experiment was tried with three waters containing a very large number of organisms, and it was found that sodium bisulphate, in the proportion of one gramme per pint, is effective after 15 minutes' contact, even for waters containing as many as 52,000 colonies of *B. typhosus* per c.c., and it is extremely unlikely that any drinking waters would be infected with bacilli exceeding in numbers per c.c. this quantity, unless a large quantity of turbid urine from a convalescent case had recently mixed with the water.

Major Macpherson has since pointed out that some of the tablets of sodium bisulphate examined by him were liable to crumble into powder, and that sodium bisulphate is somewhat deliquescent. These two opposite properties are due to mechanical difficulties of manufacture, as I have found that there are varying grades of commercial sodium bisulphate having different physical properties, and quite recently I have pointed out to Messrs. Jeyes and Co. the conditions under which a reliable tablet can be obtained.

Dr. Warner (*Public Health*, July 1901) has studied the behaviour of this salt towards other organisms, and finds that as already pointed out (Series III.) with strong solutions, although the number of typhoid organisms is very considerably diminished after 15 minutes, a longer time is necessary for sterilisation, but adds, "a contact of 30 minutes does undoubtedly, in the majority of instances, destroy *B. typhosus* in a tap water under the conditions of the experiment." This author has further pointed out that *B. enteritidis* is also killed by the reagent, and has a resistance very much of the same degree as *B. typhosus*, and that *Sp. choleræ* succumbs far more easily than either of these two organisms, and, therefore, is of the opinion that the salt would affect disinfection of contaminated wells more thoroughly than the permanganate at present in common use in India for the purpose.

Prof. Firth has also made a great number of experiments at Netley, to determine the action of bisulphate on the typhoid bacillus, and has shown that by increasing the dose to 3 grammes per pint, the sterilisation can be obtained in five minutes; and that if the excess of acidity

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is then objected to, it is easy to neutralise the water by the addition of 2 grams of bicarbonate of soda. I am glad to find that this authority is able to say in *Le Caducée* (Nov. 23rd, 1901) that "Cette methode parait eminemment pratique pour les besoins du service en campagne;" and further, that "par un emploi judicieux, le bisulfate de soude peut contribuer pour une large part a diminuer les causes d'infection de nature typhique ou cholerique portes par l'eau de boisson." Unfortunately, I am unable this evening to give you any statistics as to the effect of using this salt in South Africa, as the official returns are not yet available, but I may add that the New Zealand contingent were supplied by their Government with this means of water purification early last year, and it will be interesting to study the enteric figures in the official report, as they will give some indication of the practical value of the method, as compared with the other proposals to which I have already drawn your attention.

Fungus Pests.

How To Treat Them.

Sulphur, in one of its many forms, is one of the most effective of ordinary poisons for destroying fungus growths, but it is generally mixed with some other substance—potash, soda or lime. Great care must be exercised in the use of chemicals, for, even in the hands of practical men, they are sometimes defective, simply through a little oversight, and sometimes want of a little chemical knowledge. Resinous mixtures are found to choke the pumps. Soda and bluestone would not mix into a clear fluid, and oily mixtures were found to damage strong trees. It must, however, be clearly understood that attention to detail and the expenditure of time and careful mixing of chemicals will obviate all these difficulties. In the use of chemical remedies more harm than good is done by injudicious drenching with fluid or plastering the trees with paste or powder. A little time spent in careful spraying, dusting or painting will be found to pay better, and give better results than giving the trees a hasty overwhelming dose. It is a matter of great importance, and should always be remembered that in the early part of the season when the shoots and leaves of flowering fruit trees are tender, weaker solutions than usual should be used. The weather conditions, too, must be studied, and in a dry season one-third more water might be safely added to all the different sprays.

Luminous Worms.

A Curious Discovery.

Everyone knows the common "glow-worm," so often seen among the grass and undergrowth in many parts of England, emitting a luminous glow from a portion of its body; but why these little coleopterous insects of the *Lampyridae* family should be designated "worms," is not easy to understand. Instances of a true worm, similar to the common earth-worm, casting forth rays of light have been known both in the British Isles and in France, and have been called *Pontodcilus Phosphorcus*, having been originally observed by Allman in the south of Ireland. Recently, too, some of our troops in South Africa have come across and described such a worm, which emits a strongly-luminous or phosphorescent secretion.

This slime, according to the accounts, leaves a brilliantly luminous trail on the grass where the worm has been crawling, and remains shining for some hours after. The soldiers used to collect these worms in bottles to use as lamps for reading by, although the illumination is said to have hardly compared favourably with that of the electric light. These mysterious creatures seemed to be confined to certain districts of the eastern Transvaal, and only to put in an appearance after heavy and continuous rains.

These phosphorescent emanations are a study of great interest. It is known that some of them, at all events, have radio-active properties, and act similarly to the Rontgen rays. It has been thought by some that this phosphorescence is due to a Bacterian which lives in the slime, but this is a matter of controversy; Professor Ray Lankester, for one, being of a contrary opinion. This, then, is also a matter requiring investigation.

Movements of the Earth's Crust.

New and Interesting Observations.

Marvellously minute observation is perhaps the most notable feature of scientific research at the opening of the twentieth century. It served to discover Lord Rayleigh's argon, Professor J. J. Thomson's "matter smaller than atoms," and M. and Madame Carie's radium. Professor J. Milne's instruments detect quiverings and slopings of the earth's crust that are insensible to the most delicate spirit levels. It is now known that earthquake movements can be felt right through the earth, and all round its surface. Latterly Professor Milne has also discovered that the site of his observatory in the Isle of Wight sinks slowly during a part of the year, and rises as slowly during another part—as if the breast of the earth were heaving. For five months in a year the tall buildings in a city may be heeling over towards the west; then they come back with extreme slowness to the perpendicular, and finally cant a little to the east. Superimposed upon this ground swell are minor movements, lasting only a few days, due apparently to so slight a cause as pressure of the atmosphere. If to the east of London the barometer is high, the extra weight of the air causes a sort of dimple on the earth's face, as if a penny had been placed on a lump of jelly. Little as we feel the burden of the air it amounts to nearly 15 lbs. on every square inch of the surface of the globe, and on every square mile over twenty million tons, or over the area of the metropolis alone—600 square miles—12,000,000,000 tons. Tides have, of course, a similar effect, and it is now demonstrable that the crust of the earth is sufficiently sensible to yield to this pressure.

It seems as if this yielding of the earth's crust could be turned to use in weather forecasting. For example, if Mr. Milne's instruments were placed upon the western shores of Ireland, when they indicated a depression on their eastern side, this signal would be interpreted to mean that to the westward, out on the Atlantic, there would be a corresponding region of low pressure, in other words a storm centre. By this means the observer would be placed in possession of information regarding atmospheric changes in an oceanic area from which telegraphic notice could not be received. The barometer tells the meteorologist what is happening at his station, whereas the instruments of the seismologist tell him what is happening at a distance, and therefore what may be expected. Mr. Milne has proposed to the Royal Meteorological Society that these indications should be tested. Something of the kind has been accomplished by Mr. Napier Denison in Canada, and at the Shide Observatory in the Isle of Wight westerly displacements of the pendulum have for several years past been found to be indications of the approach of bad weather. The inquiry started by the London County Council regarding the possibility of predicting fogs has extended to Germany, and a leaflet on the subject has been issued in the "Berlin Scientific Correspondence," signed by Professor Neumayer, an official of the Imperial Admiralty. A question was addressed to the Naval Observatory at Hamburg, the manager of which confesses the extreme difficulty of fog forecasting, arising from the fact that very often in localities quite near to each other one is covered with fog while the other enjoys a bright and clear sky. The writer thinks that the origin of the trouble is the virtual stagnation of upward moving currents of the air, and that for better prognostication we must have more knowledge of the upper regions of the atmosphere, which he suggests may be obtained by kites and kite-balloons.—*Daily Telegraph.*

Stereoscopic Relief with Lantern Slides.

A method has recently been brought forward for enabling lantern slides to be shown with stereoscopic effect; that is to say, so that the objects portrayed should appear to stand out in natural relief. The lantern used is double, throwing two images together on the screen. But the two apertures are covered respectively with red and blue glasses, and each member of the audience is provided with spectacles also of red and blue glass. The combination is said to produce satisfactorily the desired result.

Why Our Teeth Decay.

It may seem a curious fact, and one the cause of which is well worth investigation, that so great a proportion of civilized human beings suffer from bad teeth. Mr. T. G. Read's theory that much of the increase in the decay of teeth—for it has been clearly demonstrated that rotten teeth are much commoner now than formerly—is due to the acid contained in the husk of wheat. In recent years roller-milling has been widely adopted in place of stone-milling, the former giving a whiter bread.

Mr. H. Candy has made chemical examinations of both kinds of flour, finding that obtained by the roller process to contain as much as 43 per cent. more acid. This acid acts on the enamel, which it gradually corrodes away and eats into the tooth.

Though roller-milling may be an economic aquisition for trade, yet our teeth, and consequently our comfort and health, are a still more important consideration.

Fresh Air for Submarines.

According to Professor Dewar, peroxide of sodium may be an excellent means of purifying the air in submarine boats. It can be made to yield oxygen and to absorb carbonic acid. This appears to be a much-needed addition to the appliances in these craft, as the crew seem to find a considerable difficulty in breathing when submerged

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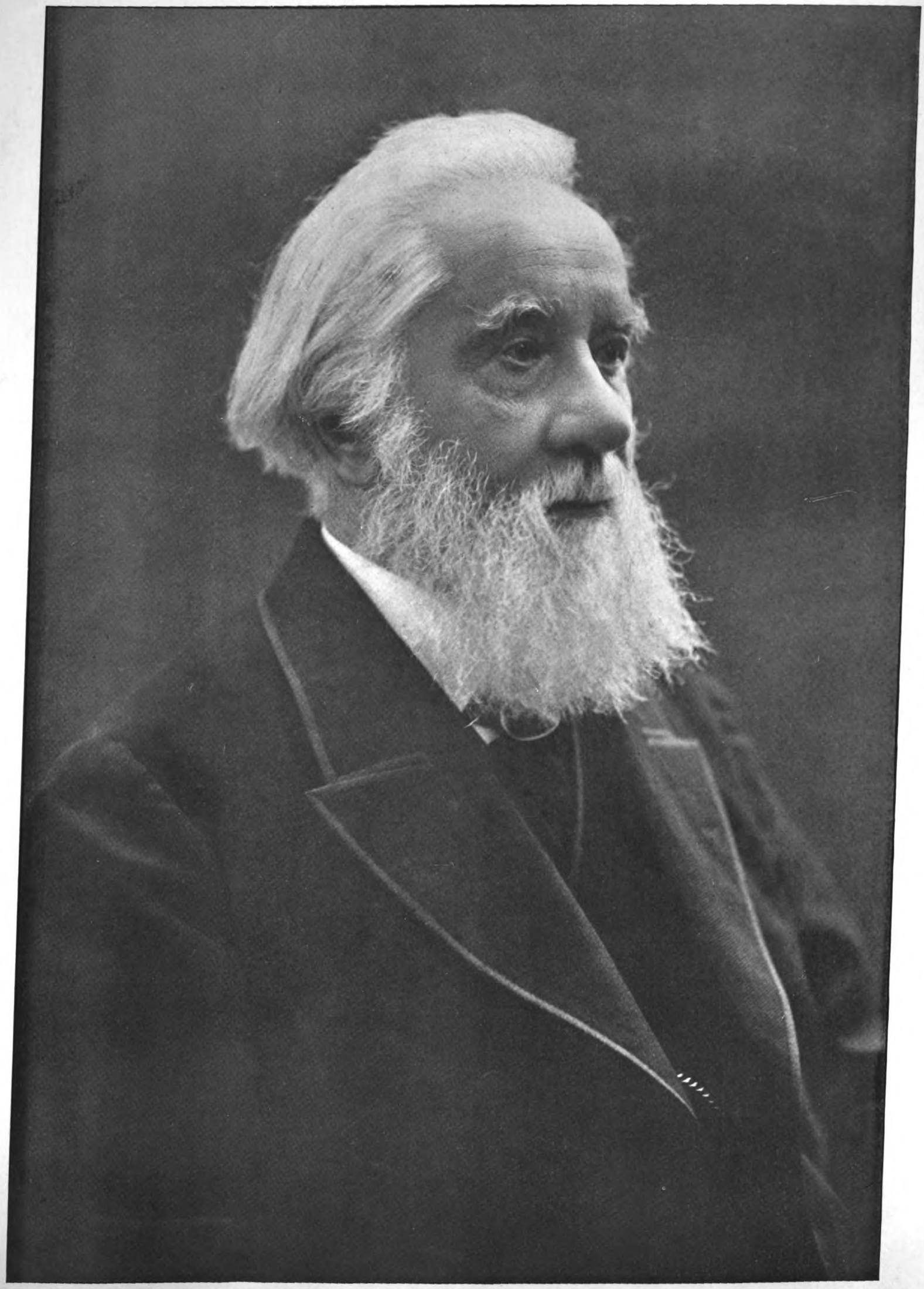

Photo, by Bassano.]

SIR WILLIAM HUGGINS, K.C.B.

President of the Royal Society.

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Fire Resisting Material.

The destructive and fatal fires which have occurred during the past few years have drawn attention to the urgent necessity of using fire-proof materials in the construction of buildings, and especially of public buildings, such as warehouses where large numbers of people are employed. Attempts have been made to treat materials used in buildings so as to render them fire-resisting, and in some cases valuable results have been reached. For instance, some time ago a number of interesting experiments were made with prepared wood, and the results showed that considerable progress had been made towards procuring a substance which would be absolutely insensible to fire. A further advance has been made in that direction by the British Uralite Company in the production of a composition which, perhaps to a higher degree than any other material yet manufactured, is capable of resisting fire. This material is termed "Uralite," and its inventor is Colonel Imchenetsky, of the Russian Artillery. About two years ago the company secured the right to manufacture the substance in this country; and they have erected an extensive factory at Higham, Kent, and have modified and improved the process. Several interesting tests were carried out at the company's works on August 13, in the presence of a number of visitors. The main ingredient of the substance is asbestos, which is sent from Canada, the United States, and Russia. This is cleansed and afterwards mixed with water and chalk, as a binding agent, into a pulp similar to that of paper pulp. The pulp is rolled into sheets, and for the purpose of securing stability a small quantity of silicate of soda is added to it. The sheets thus formed are cut into the sizes required, pressed, and dried, leaving boards of fibrous asbestos. These boards are steeped in a solution of silicate of soda; the water is driven off by drying, and they are then dipped in a solution of bicarbonate of soda and again dried. The technical application consists of the impregnation of the asbestos board by silicate of soda and its subsequent decomposition by bicarbonate of soda. This is accomplished by regulating the strength of the two solutions so as to ensure the complete impregnation of the whole of the board by the two chemicals, which are of mineral character. In this way the time of deposition is determined, and, after a sufficiency of the colloid silica is deposited over the fibres of the asbestos, it is gradually dried until the 75 per cent. of water, natural to freshly formed colloid silica, is driven off, leaving a hard, dense substance which attaches itself as a cement to the asbestos and thus forms a homogeneous mass incapable of lamination, with no planes of cleavage, and fire-resisting to a high degree.

In order to carry out the tests a small house, a hut, and a platform were utilized. To the test-house were fixed four doors. One door was constructed with two oak boards $\frac{3}{4}$in. thick. Next to the timber was a steel armour-plate, and over all was a covering of uralite. The second door, suitable for inside use, was built of two sheets of hard uralite running through the centre of the door and forming panels. The framework consisted of timber laid on either side. A door for warehouse purposes consisted of a thickness of soft uralite in the centre and oak on either side. Next to the timber was fixed a thickness of soft uralite, and the whole was covered by a layer of hard uralite. The stiles of the other door were constructed of oak, $1\frac{1}{2}$in. thick, and the panels were filled in with uralite mortar thoroughly dried. The timber was covered all over with soft uralite and on that a steel armour was fixed. The whole was covered by hard uralite. In each case the materials were fixed together by means of nails. A fire was lighted inside the house and the doors were shut. The highest temperature reached was 2,350 degs. Fahrenheit. After the test, it was found that in each case the doors had resisted the fire. It is interesting to note however, that in the case of the second door practically all the wood outside was burnt off, leaving the outer layer of uralite uninjured by the severe heat. The fire was burning for an hour. In the hut was fixed a deed-box made of uralite and wood, and in the box were placed some papers, a book, and a crucible containing paraffin wax. After being subjected to an external heat of 2,030 degs. Fahrenheit, the papers and book were not in the slightest degree charred. The wood nearest the fire was charred right through, but the middle layer of uralite was sound and the paraffin wax had only melted. The platform was 12 feet long and 6 feet wide, it was built of wood, but one half was covered with uralite. After the fire had burnt underneath it and had reached 2,270 degs. Fahrenheit, the unprotected portion was completely destroyed, but that covered with uralite was whole and strong enough to stand the weight of a man. In addition to its being fire-resisting, the company claim that uralite is not affected by cold or acid, and thus it may be said to have distinct advantages over corrugated iron. It is supplied for roofings, ceilings, floors, and partitions, and can be veneered, varnished, and worked with carpenters' tools like ordinary timber.

"The Times."

Photographic Prints.

Many photographic prints are spoiled by being dried between sheets of blotting-paper, which is impregnated with injurious chemicals. Care should be taken only to use such paper as is guaranteed to be suitable for the purpose.

Sir William Huggins,

K.C.B., P.R.S., D.C.L., LL.D., Ph.D., D.Sc., &c.

The topmost pinnacle of the worldly career to which the English man of science may attain is the position of President of the Royal Society, and the mere fact of occupying this exalted seat is sufficient to show that its occupant has achieved, by exceptional ability, such triumphs over Nature as are beyond the reach of the average man.

Sir William Huggins, the present holder of the post, was born in 1824, in London. He received a scientific education, and in 1856 built and equipped a private astronomical observatory on Tulse Hill, where he has lived and laboured ever since with such remarkable success. For three years his investigations were confined to ordinary observations and measurements of the heavenly bodies, but after this period the discoveries of Kirchhoff and Bunsen, showing that the vapour from heated substances produced spectroscopic characteristics by which the existence of known elements in the sun could be proved, attracted his attention, and he resolved to devote his studies to investigations in this new sphere.

Realizing that by such means much was to be learnt regarding the stellar universe, he set to work devising methods by which the spectra of the stars could be ascertained. Considering that a star of the first magnitude gives but one forty thousand millionth part of the light of the sun, it may be imagined that this was no easy task, and that very different methods had to be adopted. However, in his hands, the subject developed to such an extent that it has now become a distinct branch of Science under the name of Astrophysics.

Among the more prominent discoveries which are due to Sir William Huggins may be mentioned the presence of substances existing on the earth, such as hydrogen, sodium, magnesium, calcium, and iron, in the stars; that the stars are practically of the same constitution as the sun; that the principal nebulæ are masses of gas in a luminous state; that the light of comets is partly reflected and partly emitted, and that the latter is principally due to luminous vapour of carbon, but also to other substances; the photographing of the sun's corona even when not eclipsed; the first estimation, by spectroscopic means, of movements of stars towards or from the earth.

In 1875, Sir William married the daughter of Mr. John Murray, of Dublin, who has ever since been his active assistant.

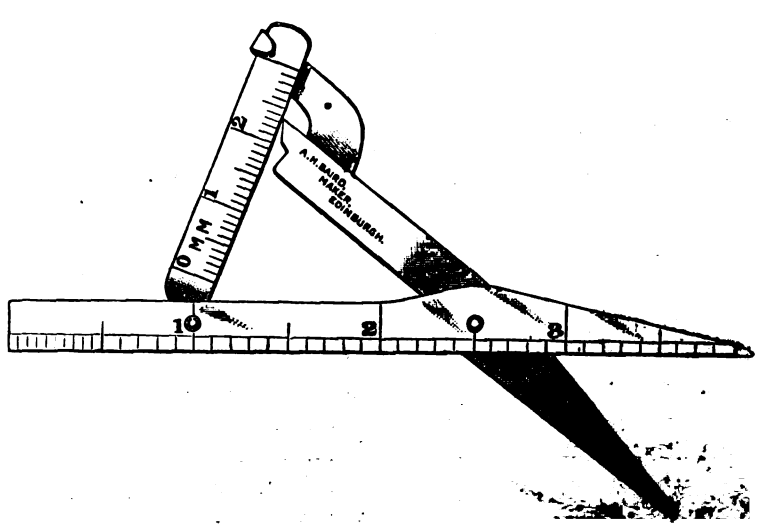
From 1876 to 1878 he was President of the Royal Astronomical Society; in 1891 was President of the British Association.

In recognition of his many and great services to Science, Sir William has received a large number of honours and distinctions. He was awarded the Royal medal of the Royal Society, the Rumford and Copley medals, twice the gold medal of the Royal Astronomical Society, the Lalande Prize of the Academy of Sciences of Paris, as well as many other foreign awards. He has also received degrees from most of the universities.

In 1897 he was created a Knight Commander of the Bath, and in 1902 was appointed one of the twelve original members of the New Order of Merit.

A Measuring Instrument for Naturalists.

A simple little instrument, devised by Sir Joseph Hooker, has been put on the market by Mr. Baird, of Edinburgh. It is known as the "Kew Micrometer." The illustration is sufficiently explanatory without our going into a long description of it. It will be understood that it is merely necessary to measure off the object with the points of the



dividers, and the scale on the cross-piece shows the length at once without necessitating the remeasuring on a separate measuring rule. For work under the microscope this should be of especial advantage. One side of the scale being graduated to inches and fractions, the other to millimetres is a great advantage, as the measurement can then be recorded in either or both systems.

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A New Shallow-Draught Steamer.

Messrs. Yarrow, of Poplar, have recently completed a new steamer for navigating shallow waters, on a principle which seems likely to be much adopted in future for such purposes.

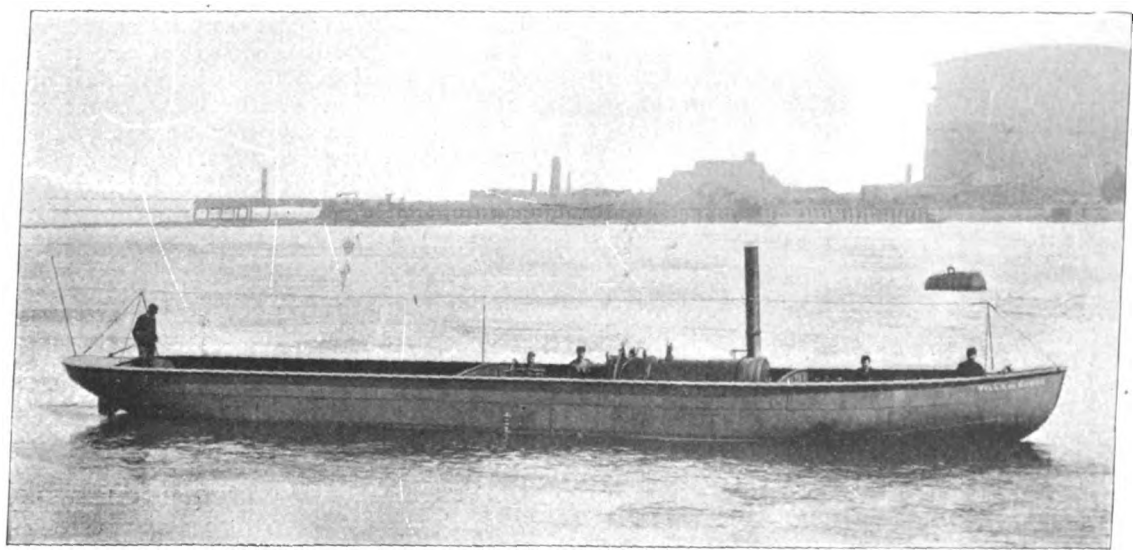
The known systems of propelling vessels by side paddle-wheels or stern-wheels are open to the objection that when the vessels are loaded the propellers are more deeply immersed, and, consequently, the speed and power will vary. The machinery for driving paddle-wheels is also heavier and more bulky than that required for screw propellers. For use in unfrequented rivers, too, the blades are apt to be damaged by pieces of floating timber.

The ordinary screw propeller is not applicable when the draught is very limited, since the diameter of the screw cannot exceed the draught of water. Thus, in the new boat the draught, when running light, is only 11 ins. So that if navigating waters only one foot deep, only a very small propeller would be possible were it not for the new arrangement.

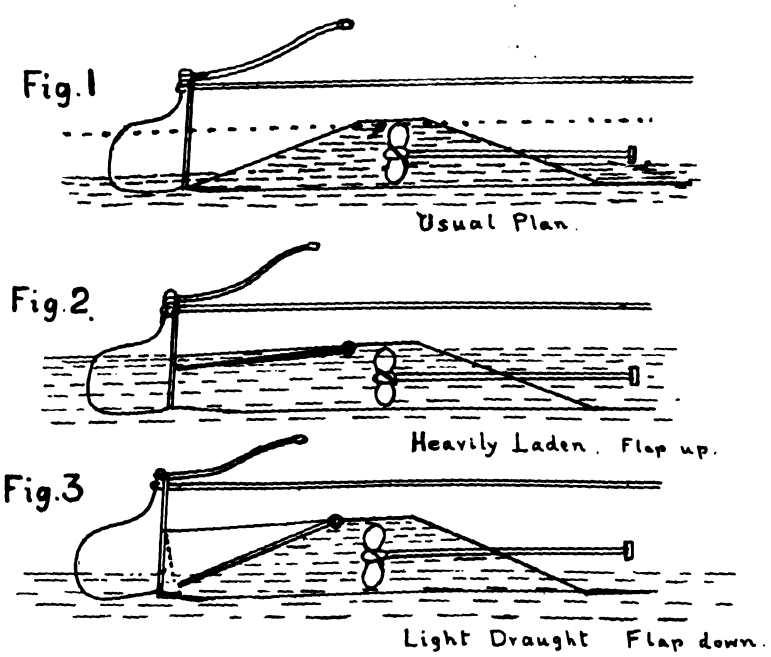
Another system lately introduced is to place the screw propeller in a tunnel formed in the bottom of the hull near the stern. The upper part of the tunnel is considerably above the water line. This tunnel is sloped away both forward and aft, with the result that, as the propeller revolves, water is drawn up so as to fill the tunnel, and is driven down again towards the stern.

A number of boats have been built on this principle, notably the gunboats *Teal* and *Moorhen*, and for men-of-war, which seldom vary greatly in their loads, this system does well. For cargo-carrying purposes, however, where there may be large variations in the draught, a loss of efficiency is involved when the vessel is fully loaded, owing to the after end of the tunnel being lower than is required, and the posterior-inclined surface acts as a drag. Fig 1. shows a section of such a boat, from which it can easily be understood how, when the vessel is fully immersed, the after sloping portion is both useless and even an impediment.

In the new vessel which Messrs. Yarrow have just completed, the tunnel is constructed, as in Fig. 2, so that when fully immersed the propeller acts directly on the mass of water behind, just as in any ordinary screw-propelled boat. But a hinged flap is provided which can be raised or lowered as required, so that when the vessel is only lightly laden, it can be lowered and the water forced downwards. It is found in practice that the boat with an average load of 10 tons goes 7½ miles an hour with flap lowered, and 8 miles an hour when it is raised, so that there is a gain of ½ a mile an hour without any extra expenditure of force.



Yarrow-system Launch.



Polonium.

This new substance, discovered by M. and Madame Curie, is now considered by them not to be a new element, but a compound of bismuth, they having been unable to isolate it after a great number of attempts. M. Marckwald, however, has obtained a small quantity of polonium in a way which apparently excludes the possibility of identifying this substance with bismuth. This was extracted from the residue of pitch-blende. The total weight obtained was only five milligrammes, which corresponds to an amount of only one gramme to the ton of pitch-blende, but he hopes to be able to extract a sufficient quantity in this manner to determine its atomic weight.

Optical Phenomenon.

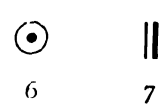
A correspondent has sent us a curious little example of one of those optical illusions which are often so inexplicable, and which we do not remember to have seen before.

The first figure, simply a small circle of a definite size, is the simplest and most convincing. On placing this within about six inches of the eye (the distance will probably vary according to the strength of the eyesight) it will appear as a black dot with a cloudy halo around it.

When the white centre of the circle is greater than about one-eighth of an inch diameter, nothing particular is noticeable, but when less than this size and the circle consists of a thin ring, it appears as a small black dot when brought quite close to the eye. If, however, the containing ring is thickened the white centre always remains visible.

In Figs. 3, 4, and 5, the inner circle is one-tenth-inch across, the thin ring appearing as a dot at three or four inches distance, the medium size only doing so close; and again the thick ring, though a dark blurr comes to one side on close examination, still refuses to give up its white centre.

The converse of this effect is seen in Fig. 6, where a black dot is surrounded by a circle. When placed near the eye, the figure appears to have a distinct white centre. Fig. 7 shows a similar effect with two parallel straight lines.



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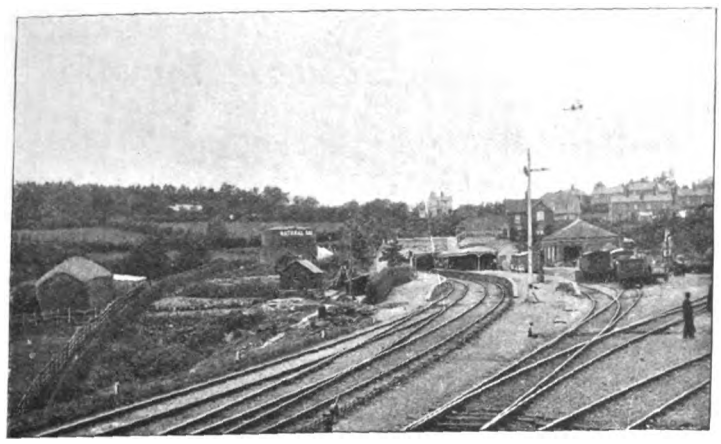
Natural Gas in Sussex.

A Wonderful Find.

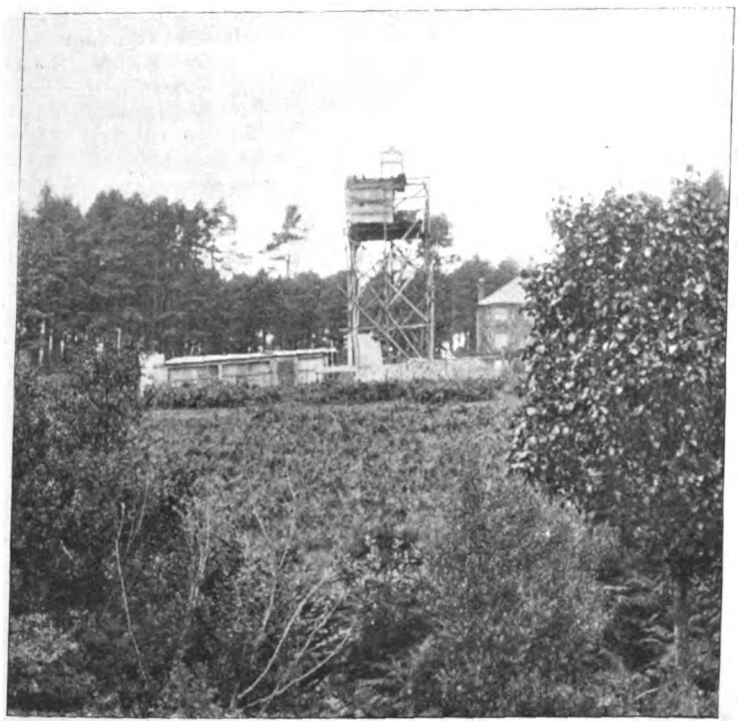
The remarkable find of a large field of natural gas within 50 miles of London opens a vista of vast possibilities. Bearing in mind the rapid and extraordinary development of Pittsburg, in the United States, owing to the natural gas found in that vicinity, we may well enquire as to whether the little rustic village of Heathfield may not, within a few years, grow into one of our principal centres of industry. At all events, if the industries do not go to Heathfield, the latter may be able



Heathfield Station, 1902.

to supply fuel to many neighbouring towns, perhaps including London, for in America it has been found worth while laying pipes to convey the gas to places 200 miles distant.

According to the *Times*, the gas supply was first discovered some six years ago while boring for water at Heathfield railway station. On reaching a depth of 312 feet the presence of gas was so strongly evident that a light was applied to the top of the tube, with the result that there was a huge burst of flame, which was extinguished with considerable difficulty. It was found that the pressure of the gas was as great as 140 lbs. to the square inch, and this pressure continues to the present day. The railway authorities took advantage of this gas to illuminate the station, for it was found to possess, unlike that existing in America, very good illuminating properties, giving about 12 to 14 candle power, or not much inferior to the gas supplied in London. This



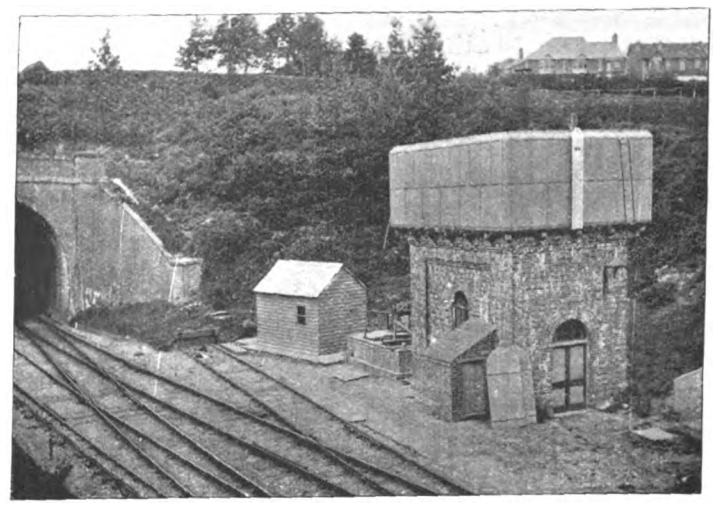
Boring East of Station.

natural gas also possesses a high calorific value, and therefore gives good results with incandescent mantles, a smaller volume being consumed for equal light than with ordinary coal gas.

About a year or so ago some American gentlemen made investigations, with the result that a company, the Natural Gas Fields of England, Limited, has started boring operations at many points in the neighbourhood to ascertain the extent and capabilities of the field. One shaft reaches a depth of 400 feet, and work is being carried on night and day, the gas itself supplying both light and the power required. In the deepest hole there is a pressure of 200 lbs. to the square inch—more than the working pressure of most locomotives—which pressure should be sufficient to carry the gas to any of the large cities of England. The output of one boring alone is something like 15 million cubic feet a day, or about one-eighth of the total daily sale of gas in London, and it is believed that a similar amount can be obtained from any other boring of like depth, and that the borings can be indefinitely multiplied without the yield of each being sensibly affected. The gas comes from the Kimeridge clays, and the area over which these are known to extend makes it probable that the English gasfield is larger than any known to exist in America. It would be worth finding out if the same formation does not extend below such centres as Portsmouth and Southampton. An analysis has shown that the gas contains:—

72½ per cent. of marsh gas.
5½ ,, ,, ,, higher hydro-carbons.
4 ,, ,, ,, carbon monoxide.
18 ,, ,, ,, oxygen.

It thus seems well suited for domestic use, and is already supplied to a number of houses in Heathfield both for illumination and also for supplying gas engines. One of the latter, of 1½-horse power, is



The Spot where Natural Gas was first found.

stated to be working with a consumption of 15 cubic feet per horse power, or about half the quantity of ordinary London gas often required.

We give herewith several views of Heathfield Station and the neighbourhood (specially taken by our photographer). It will be interesting to see whether in, say, 10 years hence there will be any great change.

An Economical Lamp.

A New Method of Producing Acetylene.

Acetylene Lamps, as hitherto worked, have formed a handy method of producing a beautiful and powerful light. But they were open to several objections, nearly all of which may be traced to the use of water, which is necessary to produce the gas from the carbide. By an entirely new method, the details of which are not yet for publication, the gas can be produced in a practical manner, without the necessity of any water. Two dry powders are placed in a vessel and shaken together, when a good supply of gas is at once given off. This practically obviates the chance of explosion, does not rely on any definite and regular supply of water, and forms a cleanly and convenient process of obtaining the gas. A syndicate (Acetylene Dry Generation and Residues, Ltd., of Notting Hill, W.) has taken up the patent rights, and is now completing a practical apparatus for the production of acetylene on a large scale.

The system, which we have seen in action, should prove of the greatest use, not only for small lamps, such as signalling and bicycle lamps, but for the lighting of country houses and even small towns. A military signalling lamp on this principle is now undergoing trials by the authorities at Aldershot.

Another advantage of this method of producing acetylene is that the very disagreeable odour of the gas is very greatly neutralized.

As regards the cost of this system, a still more extraordinary announcement is made, for the proprietors are able to show that the residue remaining after the gas is given off is of a market value very nearly equal to that of the original ingredients, so that it would appear as if in future we are, Aladdin-like, to give back our old lamps in exchange for new, and illuminate our houses for nothing!

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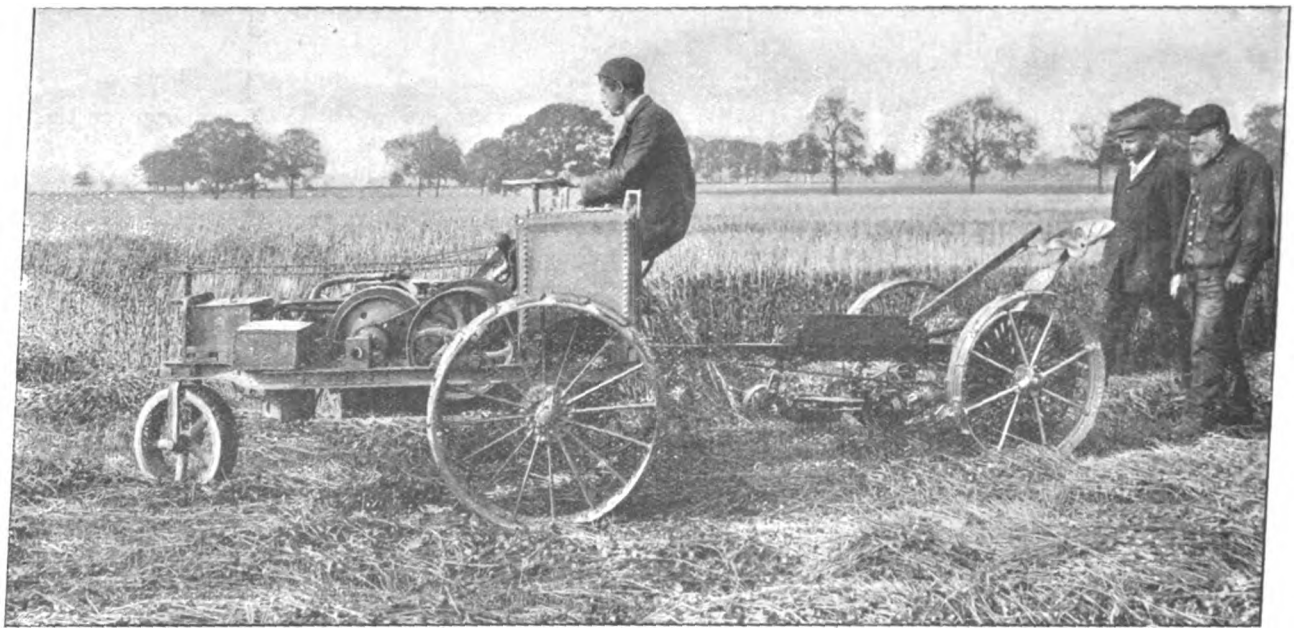
Ploughing and Reaping by Motor.

Self-propelled vehicles seem as if they would undoubtedly soon oust the draught-horse from all his erstwhile duties. It is not only on the road, where speed is so important a factor, but the fields are now to be invaded, and the power and economy of machinery demonstrated to the detriment of horse-flesh. Mr. Dan Albone, of Biggleswade, has lately introduced his "Ivel Agricultural Motor," and has been drawing ploughs and reaping machines as well as cutting chaff, grinding corn, etc., on several farms in Lincolnshire. This machine is a petrol motor of 8-horse power, with double cylinders, and water circulation. The engine is free, and when put in motion a friction-clutch transmits the power to the balance gear shaft of the road wheels. The wheels have extra wide rims with grips to prevent skidding, and can be fitted with detachable rubber pads for travelling on roads. The weight of the machine complete is 17 cwt. 7 lbs. The motor is used simply as a horse, or rather team of horses, to draw along any agricultural machine behind it.



Ivel Agricultural Motor.

The New Giraffes at the Zoological Gardens.

No more valuable addition has been made to the collection of living animals in the Zoological Society's Gardens than the pair of young giraffes of which we now give the portraits from a photograph or plate. The giraffes, which were received in July last, were presented to the Zoological Society by Colonel B. Mahon, C.B., the Anglo-Egyptian Governor of Kordofan. They were captured when quite young, in the desert, and were kept for some time in Colonel Mahon's "compound" at El Obeid. When the Governor heard that they would be much appreciated in the Regent's Park he kindly offered them to the Zoological Society, if an opportunity could be found for transmitting them to Europe. This was a rather difficult undertaking, and could hardly have been executed without the kind assistance of Captain Flower, the Director of the Zoological Gardens at Ghizeh, near Cairo, who offered to render the Society (of which his father, the late Sir William Flower, was formerly the well-known President) his most efficient assistance. In the first place, the giraffes were marched down to the Nile, and along its banks by the caravan route to Khartoum, where they were received and cared for by Mr. Butler, the Director of the Soudan Wild Animals Department and one of the Corresponding Members of the Society. From Khartoum they were transmitted by railway to Wady Halfa, where, according to the regulations of the Egyptian Government now in force, they were compelled to remain in quarantine for a certain period. From Wady Halfa, Captain Flower, who had a giraffe destined for the Ghizeh Gardens at the same place, superintended the conveyance of the giraffes to Cairo, where they were lodged in the Ghizeh Gardens. At Cairo, the animals, which had borne their long journey remarkably well, were received by Mr. Arthur Thompson, the Assistant Superintendent of the Zoological Society, who had been sent out by the Council of the Society, to bring them home. They were shipped by Mr. Thompson in one of the B.I.S.N. Company's vessels at Ismailia, and reached London in excellent health and condition, in spite of some severe weather in the Bay of Biscay.

The newly-arrived giraffes are of special interest because they belong to the Nubian or Northern form of this animal, whereas those lately received in London have all been obtained from South Africa. The northern and southern giraffes present certain points of difference, both as regards the markings of the skin and also in the presence of a posterior pair of horns in the southern form, which are but very slightly developed in the northern animal. These differences have led some Zoologists to conclude that there are two distinct species of giraffe in Africa. But it is highly probable that when the subject has been further investigated, intermediate forms will be found to occur, as the giraffe has been found, in localities suitable to its habits, in nearly every part of Eastern Africa, between Cape Colony and Dongola.

The first living giraffe known to have been brought to England was presented to King George IV. in 1827 by Mohammed Ali, then Viceroy of Egypt, but only lived a few months at Windsor. About seven years after this the Council of the Zoological Society determined to endeavour to obtain living specimens of this remarkable animal for their menagerie, and entered into an arrangement with a French traveller, Thibaut, who was well acquainted with Nubia, for this purpose. Thibaut carried out his mission admirably, and in the summer of 1835 succeeded in lodging in safety at the Society's Gardens two pairs of these animals.

The giraffes obtained from M. Thibaut succeeded in the most

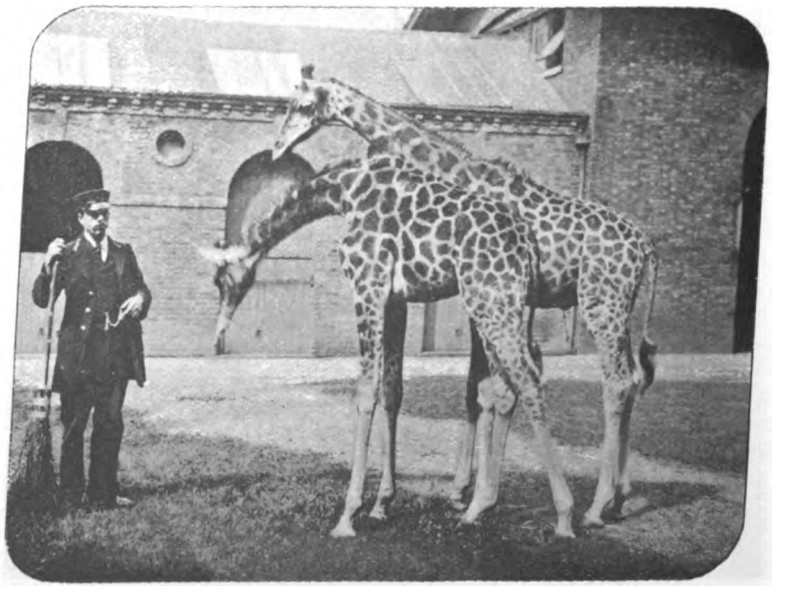


Photo. by W. P. Dando.

remarkable manner, and no less than seventeen individuals were bred by them and their descendants in the Society's Gardens. In consequence, however, of an unfortunate fire and other incidents, the stock, after thriving for many years, became much reduced, and in 1892 the last survivor died, leaving the Society's menagerie without any specimen of this remarkable mammal. At this period, in consequence of the closure of the Soudan by the Mahdists, it was

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impossible to procure giraffes from that quarter, but about three years later, in 1895, examples of this much desired animal were procured from South Africa, and the serious vacuity, which had prevailed for several years, came to an end. Besides the pair of Nubian giraffes of which we give figures, the Zoological Society's giraffe-house at present contains a fully adult female of the South African form, purchased in 1895. A male of the same form subsequently obtained was for some time in poor condition, and unfortunately died last year. But now that the *pax Britannica* has been effectively established in the Soudan, there will be no longer much difficulty in obtaining examples of this most interesting animal for European menageries.

P. L. S.

Occult Transmission of News.

So-Called Mysterious Telegraphy Among Natives.

Again and again we read of instances of natives, in many different parts of the world, being able to communicate intelligence to long distances, in a manner quite inexplicable to modern scientific minds.

The "Spectator" recently (August 16) reopened the subject in an able article, but so many of the instances quoted, like those of prophecy, spiritualism, and kindred subjects, are so wanting in proper authenticity that their accuracy may be doubted. Wonderful stories always improve in the telling, and we must be in possession of all the details and circumstances of these so-called extraordinary occurrences before we can give an opinion, or even give credence to the incomprehensible accounts. Many of these tales, if we deduct that which may very reasonably have been added during the repetition from mouth to mouth, can be easily accounted for. Thus, for instance, a Reuter's correspondent, referring to the Boer intelligence, which is hinted may be aided by certain occult characteristics of the Kaffirs, says "their scouts, or spies as they call them, were so well posted that if a British column or convoy moved from any post, all the commandoes within 70 miles knew it the same day." But such methods seem quite capable of explanation. Scouts upon a hill-top could watch the movements of a column from 10 miles off. Having made their observation they would gallop to some camp or farmhouse, perhaps 20 miles away, in a couple of hours, and messengers from there might be despatched to warn any commando, even 40 miles off. And in this way it would be nothing unusual for a Boer general to know full details of the movement of a column 70 miles off, within six or eight hours.

Another rapid method of communicating certain facts, mysterious as it may seem in its rapidity, is really very old and well-known, and that is by means of beacons or signal-fires. These were said to be much used by the Boers during the late war, and if a fire lit on a certain hill, infers a certain meaning, and if watchers were on the look out, intelligence could be conveyed over many hundreds of miles of country with a rapidity probably greater than that of the ordinary telegraphic message. Such beacon signals are much used among natives in many parts of the world; New Guinea, for instance. In any thickly-populated country, such as India, news is bound to travel fast. Out of thousands of human beings gossiping in the bazaar, hundreds will ride or drive off to neighbouring villages in the course of an hour, and from each village tens will go on to more outlying districts, and thus news will travel, even without any systematic organization, from mouth to mouth at a rate nearly equal to that of the ordinary means of progression of the country. One is apt to forget that this, without having to allow for rest and feeding, etc., may imply a continuous rate of progress of perhaps five or six miles an hour, and that thus news may easily travel over 100 miles in a day.

In most of these mysterious narratives it is only mentioned that the news travelled faster than by ordinary means of communication. Where railways and telegraphs do not exist, messages could seldom travel faster than the rates above referred to.

Native accounts, too, are very unreliable. If a case can be quoted of a native foretelling something which actually happens later on, how many can be told where the occurrence described never took place after all! It is said that during the Siege of Mafeking, long before any force was sent to its relief, a native got into the town and reported having seen a British column only a few days' march away. He gave details of its composition, and described the personal appearance of its leader, but, as it transpired, this was all pure invention. Had a force chanced to come that way, doubtless a good story could have been made of the circumstance.

Being unacquainted with any thoroughly authentic and detailed account of intelligence having been conveyed over great distances in an inexplicable way, we are, for this reason, inclined to doubt whether any mystic power with which modern science is unacquainted exists. But at the same time there are certain phenomena of a kindred nature, such as the instinct which takes a dog home after being carried for many miles in a closed box, which are so unaccountable to our present knowledge, that far from casting ridicule on these stories, we would rather ask for more.

REVIEWS OF BOOKS.

ASTRONOMY.

A Popular History of Astronomy, by Agnes M. Clerke (A. & C. Black), 15s., appears in its fourth edition as attractive as ever. If not an exhaustive history of the subject, it is as full of detail of all the modern discoveries and investigations as anyone except the expert astronomer could possibly want. In close on 500 pages is contained a large amount of matter, concisely put, and in such language as is readily comprehensible to the everyday reader. The illustrations from photographs are all too few, and the appendices, including a very complete chronological history from "1774-1803" (which should read "1901"), a list of the elements in the sun, and a complete list of great telescopes are most valuable for reference.

AERONAUTICS.

Aerial Navigation, by Frederick Walker, C.E. (Crosby Lockwood and Son), is a most disappointing book. On first glancing through it one would suppose it to be a complete exposition of the whole subject, commencing with bird and insect flight, going on with the theories of air pressures and aerostatics, describing the history of all past attempts to navigate the air, and ending with descriptions of suitable motors, materials, and methods for application to air ship. When more carefully looked into, however, it will be found that each of these subjects is by no means exhaustively treated of. Some curious, and we might perhaps say exploded, ideas on bird flight are expounded, many of the most recent conclusions on aerodynamics as results of the experiments of Langley, Lilienthal, Hargraves, W. G. Walker (not the author), and others are absolutely ignored, and, while accounts are given of many peculiar arrangements of mechanism, most of which we expect have never reached a stage beyond the drawings of the would-be inventor, many, we may almost say most, of the real attempts to construct man-carrying machines—those of Phillips, Ader, Hargraves, and Kress—are entirely ignored, as are the interesting and important experiments of Pilcher, Lilienthal, Chanute, and Wright. Moreover, the biggest and most scientifically constructed of machines to navigate the air, those of Maxim, Zeppelin, and Langley, receive but the barest notice, the accounts evidently being compiled from the Patent specifications without reference to the very different methods employed in the practical carrying out of the idea. Professor Langley's apparatus, for instance, of which we hope to hear some "big things" during the next few months, is referred to as having an "aerostat" (presumably a gas vessel) in its upper part, which is certainly contrary to most hitherto published accounts of the inventor's ideas. Dr. Barton is quoted as having "just built an airship in the United States"; instead of that he is *about* to build one in London. There seem to be some miscalculations, too, in the theoretical part. It is said that it is not practical to construct a machine to carry a man depending "upon his unaided efforts to produce the required velocity of motion and power," *because* if the man and machine weigh 160 lbs., and the "rate of velocity" (presumably meaning the rate of ascent) be 60 ft. a minute, 9600 foot pounds would be required, whereas a man is only capable of exerting 4123 foot pounds. Surely by the same line of argument it could be proved that a man could not run upstairs 60 ft. high in a minute! Though this work then cannot be recommended as a complete or even reliable guide to the aeronaut of the future, still many useful hints may be gathered from it, and, though others may be shortly looked for, it is practically the only book published in England during recent years on this most promising subject.

BOTANY.

Elementary Plant Physiology, by Dr. D. T. MacDougal, Director of the Laboratories, New York Botanical Gardens (Longmans, Green, and Co.), is a handy little volume on what may be called the "doctoring" of plants. The book is divided under the headings of "Growth," "Reproduction and Germination," "Exchange and Movements of Gases and Liquids," "Nutrition," "Respiration, Digestion, and Fermentation," and "Stimulation and Correlation." A number of most interesting experiments, almost suggestive of vivisection, are clearly explained by aid of plentiful illustrations,

HYGIENE.

The Earth in Relation to the Preservation and Destruction of Contagia, by Dr. George Vivian Poore (Longmans, Green, and Co.), 5s., treats of a subject which is of the greatest importance, especially to those who are the caretakers of the health of a community. The soil is shown to be responsible for the propagation of a great many ills. The causes of dysentery, cholera, plague, malaria, enteric, and many other diseases are gone into, and the trouble can generally be traced as coming from the earth. The disposal of sewage, the pollution of water supplies, agricultural manures, and other matters bearing on the dissemination of diseases all receive careful attention, and this book should prove invaluable to doctors, architects, and to all who have at heart the healthiness of dwellings.

GEOGRAPHY.

The World-Wide Atlas of Modern Geography, with an introduction of the Geographical changes in the Nineteenth Century by J. Scott Keltie, LL.D., &c. (W. & A. K. Johnston), 7s. 6d., has this year reached its fifth edition, and has been considerably enlarged and improved. The introduction, of 13 pages, gives a very clear and concise history of the greater territorial changes during the last hundred years. In addition to the ordinary maps are a number of plans of principal towns, and also some good physical maps of the British Isles and of the Continents. A very complete index is added.

Atlas of Physical Geography (W. & A. K. Johnston), 12s. 6d., is another well-known work newly revised and enlarged (though undated). There is a very full "description of the plates," followed by a series of excellent maps, not only showing the ordinary physical features, but also the geological, meteorological, and other characteristics. It is a pity the backs of the pages of plates are not numbered, as making it more easy for reference.

EDUCATION.

The Making of Citizens a study in comparative education by R. E. Hughes (The Walter Scott Publishing Co.), is an account of the educational systems prevalent in England, Germany, France, and the United States. It is interesting to compare the methods by which each nation trains its youth, and here will be found a valuable collection of statistics and facts which should prove of the greatest utility to all who study the principles of education.

METALLURGY.

Assaying and Metallurgical Analysis, by E. L. Rhead and A. Humboldt Senton (Longmans, Green & Co., 10s. 6d.), should form a most useful handbook for students, chemists and assayers, as including full information on most of the work likely to be required in the Laboratory or Assay Office. The various operations are described in great detail, illustrated when necessary with clear drawings, and a good index completes a work which should find its place on the bookshelves of all interested in metallurgy.

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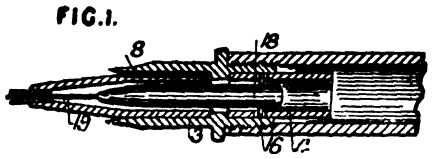
Recent Patents

Selected from the IIId. Official Journal.

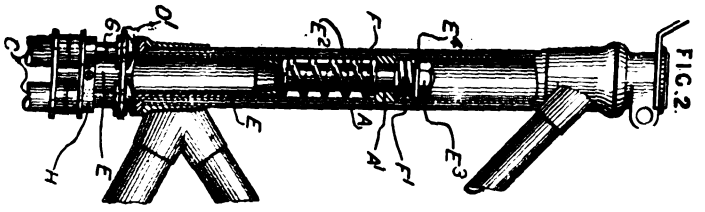
8860. Stylographic Pens. Sanford, W. W., 65, North 18th Street, East Orange, and Bennett, F. D., 17, West Main Street, Freehold, both in New Jersey, U.S.A. April 30.

FIG.1.



Relates to a pen in which all the parts are assembled in the removable head. The needle 19 carries a weight 18 provided with pins 16, which rests in slots in the ink tube 4. An air duct 8 is formed between the tube 4 and the inner surface of the head 3. The pen is filled with ink from the front after unscrewing the head 3.

8872. Cycles; motor road vehicles.—Belcher, H., and Humber (Limited), Beeston, Nottinghamshire. April 30.



Relates to spring steering-heads for cycles, motor and like vehicles, &c. The forks C are secured to a tube E, adapted to slide vertically in the steering-post A, the motion being controlled by springs F, F1, arranged on each side of a flange A1 secured in the post A, and surrounding a stem E2 secured to the tube E and sliding in the flange A1. A nut E3 and washer E4 secure the spring F1 in position. Relative rotation between the tube E and post A is prevented, either by making the stem E2 and the opening in the flange A1 square, or, as in the arrangement shown, forming sockets in the fork crown H adapted to slide on guides G carried by a crown plate D1 secured to the tube A.

8894. Valves. Golby, F. W., 36, Chancery Lane, Middlesex.—(*Hass, S. A. S.; Vesterbrogade, Copenhagen.*) April 30.

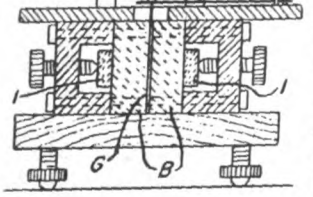
FIG.1.

FIG.4.

Self-closing valves.—The casing A has a partition and flanged end wall E, through which a tube A1 can slide. A leather packing-sleeve B is secured to the end wall by a fastening D, Fig. 4, and is pressed against the tube by a spiral spring C. The tube has a closed inner end, and by means of a handle G can be slid away from the outlet so as to expose a series of perforations L near the closed end.

8943. Magnetic Measurements. Baily, F. G., 11, Ramsay Garden, Edinburgh. May 1.

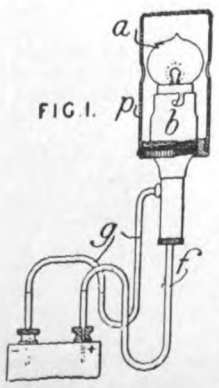
FIG.4.



The permeability of two iron or other specimen rods, with a definite magnetizing force, is measured directly by making them the chief parts in a magnetic circuit, magnetizing them by passing a measured electric current through surrounding coils, causing a part of the magnetic flux to deflect a freely-movable magnetic system, returning this to a zero position by adjusting the position of a small coil carrying the same current, and observing the position of the coil on a stationary scale. Hysteresis may be observed by use of different magnetizing currents. Fig. 4 shows a section of a suitable instrument. The two rods are placed parallel and extend through long magnetizing coils. The rear ends of the rods are clamped in holes in a soft iron block, and their front ends I are clamped in two blocks B, separated by a thin flat plate of copper G. The magnet system S1 may consist of two magnets, arranged astatically, and suspended with two poles near the copper plate G, the upper poles being within the small coil C, which can be turned on on a horizontal table. The magnet system has a pointer P extending between stops, which allow a small movement from a zero mark. The small coil carries a pointer over a graduated arc.

9023. Galvanic Batteries. Bristol, L., 40, Great Smith Street, Westminster, London. May 1.

FIG.1.



Secondary batteries, indicating charge in. A small incandescent lamp *a* is carried by a holder *b* in a cover *p*, and provided with two flexible connections *f*, *g*, or with a rigid and a flexible connection, to fit the terminals of a battery, the condition of which is shown by the brightness of the lamp as seen through holes in the cover *p*. The appliance is especially applicable for testing the ignition batteries of motor cars. It may be used for batteries other than secondary.

9188. Induction Coils. Forbes, Sir C. S., Castle Newe, Strathdon, Aberdeenshire. May 3.

FIG.1.

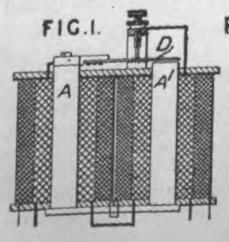
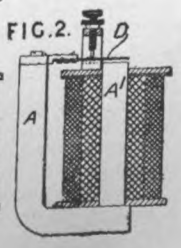


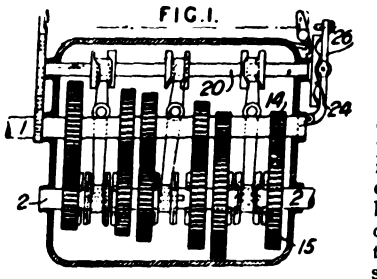
FIG.2.



Induction coils adapted for igniting charges in internal-combustion engines. The core is made more or less in the shape of a horse-shoe, and the vibrating reed is fixed at one end to one end of a core, the free end being adjacent to the other end of the core. Figs. 1 and 2 show two forms. The core A, A1 may have one or two sets of windings, D being the vibrating reed.

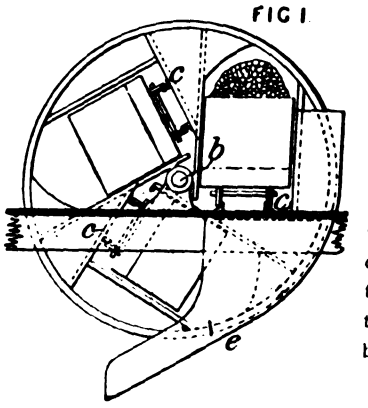
9071. Toothed Gearing. Crouan, H. M. L., 51, Avenue de la Grande Armée, Paris. May 2.

FIG.1.



Variable-speed and reversing gearing for motor cars, &c. A series of wheels fixed on the driving-shaft 1 gear with a corresponding series of wheels loose on the driven shaft 2, the wheels 14, 15 being connected through an idle pinion to obtain the reverse motion. Between each pair of loose wheels is a clutch which may be moved along the shaft, to secure either wheel or to allow both to run free, by means of a lever engaging with a cam on the shaft 20. The cams are arranged to come into action successively as the shaft is rotated by rack-and-pinion gearing worked by hand. A multiple cam disc 24 on the end of the shaft acting upon a lever 26 causes the disconnection of the engine clutch when the gearing is being changed.

FIG 1

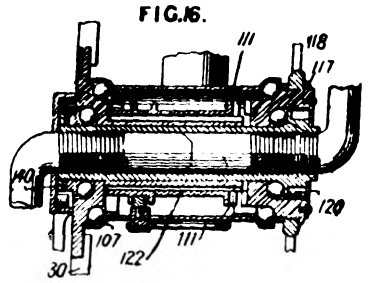


9282. Unloading. Sams, C. E. R., Shipley, Derby. May 4.

Relates to apparatus for tipping-trucks. A revolving cradle, pivoted at *b*, has three floors *c* symmetrically placed at angles of 120°, but arranged so as, when horizontal, to be below the centres *b*. A truck run on to the floor, which is horizontal, causes the cradle to rotate, at the same time tipping the coal, &c., into a shoot *e*. In the rotation of the cradle the empty trucks are brought back into position to be run off.

10,429. Motor cycles. Haddan, H. J., 18, Buckingham Street, Strand, London, W.C.—(*R. M. Keating Motor Co.; 12, Monument Square, Portland, Maine, U.S.A.*). May 20.

FIG.16.



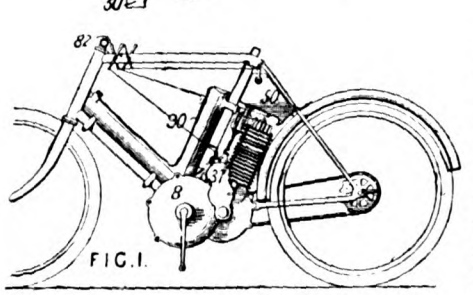


FIG.1.

Relates to a motor bicycle provided with an explosion or gasoline engine, with auxiliary pedals which reinforce the engine or by reversal uncouple the engine and apply a brake. The engine and auxiliary parts are connected to the frame and arranged as shown in Fig. 1. The engine connecting-rod 15, Fig. 4, is fixed to the piston by the pin 14, and at the lower end embraces two crank-pins 18, which project from the faces of the flywheel discs 17. The flywheel discs have annular recesses surrounding the hubs or bosses 25, and removable rings 24 extend from casing 20 into the recesses and embrace the hubs 25 so as to have bearings on both inner and outer surfaces. The gear-wheels employed are covered by the cases 8 and 37. The exhaust valve is operated by a cam and spring-pressed rod. The carburetting-tank 50, Fig. 6, is directly above the engine, and is provided with the mouth 51 to guide the hot air into the passage 52. A gauze screen 53 prevents flame from entering the passage 52. The transverse tube 60 serves as a primary mixing-chamber, and the plug 62 controls the mixing. The final mixing-chamber 70 contains metal rings and wire discs arranged alternately. An escape opening 79 in the cylinder end is controlled from the handle 82, and allows flame to pass out and warm the tank 50 when required. The various plugs or cocks are worked from the handles arranged near the handle-bar of the bicycle. The cells for the ignition are arranged in the elbow-shaped casing 90, made in two to facilitate access. The engine exhaust is led to a perforated pipe in the hollow mud guard, is baffled by plates arranged alternately in the mud guard, and is discharged near the rim of the rear wheel. The engine speed is controlled by controlling the time of the exhaust. The pedal shaft is connected with the clutch 120, Fig. 16, which by forward movement of the pedals in excess of the engine speed makes the pedals auxiliary to the engine, and with the clutch 140 which by back-pedalling uncouples the engine and applies the brake. The crank bracket 111 forms a housing for the balls 107, and the clutch ring 117 surrounds the sleeve 104, which has inclined services with rollers 120 to act as a clutch. The sleeve 122 by its movement uncouples the driving-wheel 30 from the driving-ring 117, to which the sprocket 118 is connected. It is possible to arrange so that the engine is thrown out without applying the brake. In a modified arrangement, the engine and its cylinder are made to support the saddle tube, and a brace connects the top and bottom tubes of the frame in front of the engine.

FIG.3.

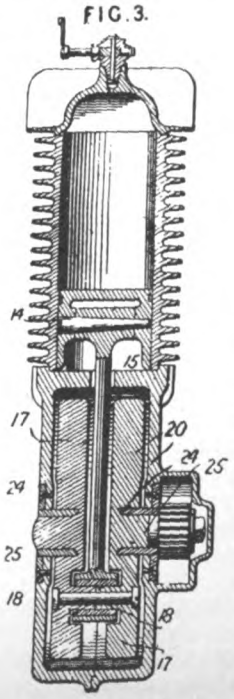
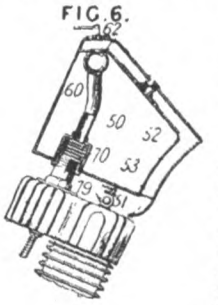


FIG.6.



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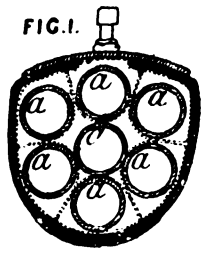
10,467. Vehicle Wheels. BALDREY, R. J., Ootacamund, Nilgiris, India. May 20.

FIG. 1.



Tyres, pneumatic.—Relates to a multitubular pneumatic tyre for vehicles such as cycles employed in military operations. The tyre, shown in section in Fig. 1, is provided with a number of separate air tubes *a*, each of which is separately inflated through its own valve. Each air tube is sufficiently large, when fully inflated, to fill the tyre completely, should the other air tubes be deflated from any cause.

The Science of Illusion.

MYSTERY NO. I.—LEVITATION.

THIS is one of the most effective and inexplicable of tricks, but nevertheless can be exhibited in any drawing-room with but short preparation, and with apparatus procurable in any village shop.

Without going into the details of the "business" which may be gone into to add to the effect, we will simply describe shortly what takes place from the point of view of the audience.

A lady (or gentleman) walks on to the stage, and after undergoing any mesmeric operations or other ceremonies, is seen to slowly rise up off her feet, and with many a graceful movement of the arms and body floats high into the air! She takes a wand in her hand and slowly waves it above her head to show that she is not suspended by any invisible wires from above, she draws it beneath her feet to prove that no glass or other support props her up. She waves her wand behind

her back to demonstrate that no bracket projects from behind to hold her. And now, to still further prove that she is veritably supported in mid-air, she takes a large hoop, passes it over her head, down around her body, and under her feet. Slowly she sinks to earth again, makes her bow, and retires.

The mystery is complete. We will leave our readers to think the matter over at their leisure, and see if they can devise a method by which the desired effect may be accomplished, while satisfactorily withstanding the tests mentioned.

In our next issue we will give a full and detailed account of how this mysterious performance may be accomplished.

Prize Competition

ONE of the principal objects of this journal being to encourage and foster the introduction and propagation of new ideas, the proprietors have decided to offer a series of money prizes to those who, in their opinion, send in the best and most practical solution of certain problems which will be set each month.

The designs must be sent in within a fortnight of the publication of the problem, *accompanied by the coupon* cut from this paper. Marks will then be allotted by the judges, and the competitor gaining the greatest amount of marks each month will be awarded the monthly prize of ONE GUINEA. But in order to encourage clever inventors, and not merely reward those who may happen to hit upon a happy idea, a GRAND PRIZE OF **ONE HUNDRED POUNDS** will be awarded at the end of the year (*i.e.* after 12 problems have been set) to that inventor who shall have gained the greatest aggregate of marks during that period, provided he shall have gained marks in at least six of the competitions (whether he has gained a monthly prize or not).

In the event of an equality of votes or other exceptional circumstances, the proprietor will decide on the fairest method of distribution.

The following rules must be strictly adhered to, and solutions sent in not in compliance with them will be disqualified.

1. The solutions sent in must be concise, yet fully descriptive of the idea intended. To comply with this they must not exceed 300 words, and not more than two simple diagrams should accompany it.
2. Solutions will be published as considered desirable by the editor.
3. Competitors may obtain patent rights for their ideas, but they must run all risk of the publication in this paper interfering with the obtaining of such rights.
4. The number of marks awarded to each solution will be published every month. Competitors may send in their designs under a fancy name for publication, but their true names and address must be inserted on the coupon, which, in the event of their winning a prize, will be published.
5. The same person may send in two or more solutions so long as a separate coupon accompanies each.
6. Novelty of design is not a *sina qua non* (since this would be extremely difficult to prove), but only the person sending a description with the coupon is entitled to reward.
7. It would add to the value if a statement be added, to say if the design has been practically tried; but to corroborate this the inventor may be called upon to give a demonstration before receiving a prize.

The subject for this month, October, will be—

"THE UTILIZATION OF TIDES,"

that is, a practical method of turning to account the great natural forces of the tides to drive machinery for pumping water, generating electricity, or other useful purpose.

COUPON.

To the Proprietor,
ILLUSTRATED SCIENTIFIC NEWS.

I herewith forward my idea for a solution of the problem on "The Utilization of Tides," according to the conditions published in your paper, and I agree to comply with those conditions.

Full Name .....

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Date .....

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Astronomical Calendar.

OCTOBER, 1902.

Month.	Day of Week.	SUN. Rises.	Sets.	Before Clock.	Right Ascension at Noon.	Apparent Declination (8th.) at Noon.	HIGH WATER. LONDON BRIDGE. Morn.	After.	MOON. Rises Morning.	Sets Afternoon.	Right Ascension at Noon.	Declination at Noon.	Age at Noon.
		H. M.	H. M.	M. S.	H. M. S.	° ′ ″	H. M.	H. M.	H. M.	H. M.	H. M S.	° ′ ″	D. H.
1	W	6 0	5 39	10 4	12 27 3	2 55 30	1 18	1 40	5 41	5 22	12 14 34	3 35 26	29 7 ●
2	Th	6 2	5 37	10 24	12 30 41	3 18 49	1 59	2 18	6 49	5 49	13 4 25	7 36 27	0 19
3	F	6 3	5 34	10 42	12 34 19	3 42 6	2 37	2 54	7 58	6 16	13 54 6	11 11 29	1 19
4	S	6 5	5 32	11 1	12 37 57	4 5 20	3 12	3 29	9 5	6 48	14 43 51	14 11 38	2 19
5	S	6 7	5 30	11 19	12 41 35	4 28 31	3 46	4 3	10 6	7 22	15 33 46	16 30 5	3 19
6	M	6 9	5 27	11 37	12 45 14	4 51 39	4 20	4 37	11 4	8 2	16 28 51	18 2 7	4 19
7	Tu	6 11	5 24	11 55	12 48 53	5 14 43	4 53	5 10	aft.	8 47	17 13 58	18 45 2	5 19
8	W	6 13	5 22	12 12	12 52 32	5 37 43	5 29	5 49	0 43	9 37	18 3 57	18 38 1	6 19
9	Th	6 15	5 20	12 28	12 56 12	6 0 39	6 10	6 34	1 21	10 32	18 53 39	17 41 49	7 19 ☽
10	F	6 16	5 18	12 45	12 59 52	6 23 30	7 2	7 31	1 59	11 32	19 43 0	15 58 36	8 19
11	S	6 18	5 16	13 1	13 3 33	6 46 16	8 6	8 47	2 32	mrn.	20 32 3	13 31 44	9 19
12	S	6 20	5 14	13 16	13 7 14	7 8 56	9 29	10 10	2 52	0 36	21 21 1	10 25 47	10 19
13	M	6 21	5 11	13 31	13 10 55	7 31 31	10 47	11 19	3 27	1 42	22 10 12	6 46 42	11 19
14	T	6 22	5 9	13 46	13 14 37	7 53 59	11 48	..	3 52	2 50	23 0 1	2 42 19s	12 19
15	W	6 24	5 7	13 59	13 18 20	8 16 20	0 13	0 35	4 17	4 2	23 51 0	1 37 11n	13 19
16	Th	6 26	5 5	14 13	13 22 3	8 38 35	0 55	1 14	4 45	5 16	0 43 38	5 58 52	14 19
17	F	6 28	5 3	14 26	13 25 47	9 0 42	1 33	1 51	5 15	6 32	1 38 23	10 6 58	15 19 ○
18	S	6 29	5 1	14 38	13 29 31	9 22 42	2 9	2 29	5 51	7 48	2 35 26	13 43 48	16 19
19	S	6 30	4 59	14 50	13 33 16	9 44 33	2 50	3 10	6 33	9 3	3 34 39	16 31 43	17 19
20	M	6 32	4 57	15 1	13 37 2	10 6 16	3 30	3 51	7 23	10 14	4 35 25	18 15 56	18 19
21	T	6 34	4 55	15 11	13 40 48	10 27 50	4 13	4 36	8 23	11 18	5 36 42	18 47 31	19 19
22	W	6 37	4 53	15 21	13 44 35	10 49 15	4 59	5 22	9 28	aft.	6 37 19	18 5 10	20 19
23	Th	6 39	4 51	15 30	13 48 22	11 10 31	5 48	6 15	10 39	0 58	7 36 17	16 14 56	21 19 ☾
24	F	6 40	4 48	15 38	13 52 10	11 31 36	6 46	7 20	11 52	1 35	8 33 0	13 28 11	22 19
25	S	6 41	4 46	15 46	13 55 59	11 52 31	7 56	8 37	mrn.	2 7	9 27 23	9 58 51	23 19
26	S	6 43	4 44	15 53	13 59 49	12 13 15	9 20	10 2	1 5	2 35	10 19 40	6 1 26	24 19
27	M	6 45	4 43	15 59	14 3 40	12 33 48	10 39	11 13	2 15	3 1	11 10 22	1 49 49n	25 19
28	T	6 46	4 41	16 4	14 7 31	12 54 9	11 45	..	3 27	3 25	12 0 2	2 23 9s	26 19
29	W	6 48	4 39	16 9	14 11 23	13 14 19	0 12	0 35	4 37	3 51	12 49 13	6 25 42	27 19
30	Th	6 50	4 37	16 13	14 15 15	13 34 16	0 57	1 19	5 41	4 17	13 38 21	10 7 9	28 19
31	F	6 52	4 35	16 16	14 19 9	13 53 59	1 38	1 56	6 51	4 46	14 27 46	13 18 1s	0 4 ●

Notes and Comments.

Some people have extraordinary notions of the relative sizes of objects at a distance. When we talk of a cloud the size of a man's hand, very different ideas are created in different minds. A correspondent writing to the *Times*, in describing the size of a meteor, says, "If an ordinary star appears to our vision about the size of half-a-crown" (can anyone grasp that?) "this ball of fire appeared to be fully as large as half the moon appears to us." What is the relative size of half-a-crown and half a moon? And why introduce the coin at all?

* * *

The recent attempts to swim across the Channel are, after all, not of much practical use. To test the limit of endurance of a human being in the water is one thing—we believe shipwrecked sailors have been known to swim for twenty-four hours—but to be attended by assistants in boats, to be fed regularly at stated intervals, to make elaborate preparations by oiling and applying masks, etc., altogether nullifies the utility of such an experiment.

* * *

A regular contributor to a contemporary, dilating on the dangers incidental to motoring, speaks of "the steam-engine (!) that travels at 40 miles an hour, driven by a man who at any moment may lose control of the steering gear, and who, at no time (!) can see where he is going or what is in front of him on account of the awful clouds of dust he raises around him." Has British soil, like dogs and chickens, learnt to rise and flee before the on-coming motor, or has Mr. "Dagonet" never been in an automobile?

* * *

There are many wranglings and diversities of opinion as to what are the proper functions of what some now call the "British Excursiation." Some have it that the whole institution could better be managed by Messrs. Cook and Son. On the other hand, in a capital letter to the *Times* (of Sept. 15th), F.R.C.S. gives some apt quotations tending to show that the "British Ass," as he dubs it, is no place for the average amateur, and a glossary of the intricate and incomprehensible terms which flow in such profusion from the mouths of some of the lecturers is urgently needed.

That Mr. Spencer was able to "navigate" the "Bubbles," or the "Won't-be-happy-till-he-gets-it" balloon from the Crystal Palace to Ealing was a truly remarkable performance, so the daily papers tell us. But it seems a great pity that he did not just finish off so successful a trial by returning to his starting point. It would just have given the *éclat* that was needed to crown so noteworthy an experiment and make it different from an ordinary balloon ascent. It was *not*, by the way, the first time that a "motor-balloon" has ascended in London, for M. Gaudron tried one some years ago with equally successful results.

NOTICES OF SOCIETIES.

The new premises of the Aeronautical Society are situated at 53, Victoria Street, Westminster, S.W.

* * *

The forty-seventh Annual Exhibition of the Royal Photographic Society of Great Britain was opened at the New Gallery (121, Regent Street), on September 26th.

* * *

The Society of Engineers paid a visit to certain works at Willesden, including those of Joseph Baker and Sons, and the Wicks Rotary Type-Casting Company, on September 24th.

Aeronautics at Bath.

An interesting display of aeronautical and other experiments took place on the 8th and 9th September at Bath, to witness which Mr. P. Y. Alexander had invited a number of gentlemen interested in such pursuits. A balloon ascent was made by M. Gaudron from the exact spot where, just 100 years ago, Garnerin effected his first ascent from Bath. Several "sounding-balloons" were also released, carrying self-recording instruments. Mr. Cody exhibited some large kites, which were flown to a great height, and Mr. Alexander showed the party over his experimental works, where were some aerial propellers, gliding machines, rotary kites, etc. Demonstrations were also given of the effects of solid carbon acid, and of thermit. Among those attending were Major Baden-Powell, Dr. Barton, Mr. E. S. Bruce, Mr. Groom-bridge, the Hon. C. Rolls, and Major Trollope.

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THE ILLUSTRATED

Scientific News.

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Scientific Anecdote.

WHEN Dr. Johnson was making his immortal tour to the Hebrides, there was at Glenmorison (as we read in Boswell's Journal) a "modest civil girl, our landlord's daughter," who "had been a year at Inverness, and learnt reading and writing, sewing, knotting, working lace, and pastry. Dr. Johnson made her a present of a book which he had bought at Inverness." And in a footnote Boswell tells us that this book was *Cocker's Arithmetic!* "Whenever this was mentioned there was a loud laugh, at which Dr. Johnson, when present, used sometimes to be a little angry." But ultimately the devoted satellite ventured to ask the great man what made him buy such a book at Inverness, and obtained a "sufficient answer. 'Why, sir, if you are to have but one book with you upon a journey, let it be a book of Science. When you have read through a book of entertainment, you know it, and it can do no more for you; but a book of Science is inexhaustible.'"

Those who write scientific books (including journals such as the *Illustrated Scientific News*) may, on the one hand, find cause for satisfaction in the thought that they are providing "inexhaustibly" for their readers; but, on the other, they will naturally be disturbed by the distinction so sharply drawn between a scientific book and a book of entertainment. The word "inexhaustible," moreover, may have a sinister meaning. A friend of mine, when we were undergraduates together, always took a particular book on Astronomy to read in bed. He never exhausted that book; nor, indeed, a single page of it; for he confessed that he was always sound asleep before he had finished the first page. I wonder if it was in this way that Dr. Johnson found *Cocker's Arithmetic* inexhaustible? Some light might have been thrown on the point if Boswell had made enquiries whether Miss M'Queen, the recipient of this interesting gift, suffered from insomnia; but this we shall probably never know.

Things have changed a little since Dr. Johnson's day, and many books of Science could now be mentioned which are also commendably entertaining; particularly in Astronomy. Even in an Arithmetic I have come across the following question:—"A man dies leaving his property to be divided between his wife and an unborn child. If the child prove to be a boy, he is to have two-thirds and the wife one-third. If a girl, she is to have one-third and the wife two-thirds. As it turns out, twins are born, a boy and a girl. How must the property be divided?" If, in Dr. Johnson's time, such questions in Arithmetic had been "according to Cocker," he might have appraised his purchase differently and possibly retained it for his own use. Things have changed however, and scientific writers no longer necessarily affect Cocker's severity of tone. Need there be any reluctance to accept the change as a welcome one? There are obvious dangers in relaxing that severity of statement which must accompany accuracy; but they may be avoided without extreme precautions. Experiments which illustrate scientific truths have long had an established place in exposition; and recently we have learnt the value of lantern-slides. Why should the picturesque not be allowed a similar place in the *language* which is used to explain scientific results? For it must be admitted that the change, though initiated, is still far from completed. The Royal Society admitted experiments from the first (it was, indeed, one of the avowed objects of the Society to meet together to see scientific experiments); and they have, many years ago, adopted lantern illustration. But the language in which communications are made to the Society is still of the soberest type. Nevertheless, there have not been wanting indications that even men in the front rank would welcome some mitigation of the scientific language. Here is a notable statement of the late Professor P. G. Tait:—"I have abstained from reading the details of any investigation (be its author who it may) which seemed to me to be unnecessarily complex. Such a course has inevitably certain disadvantages, but its manifest advantages far outweigh them." An American contemporary, in quoting these words, sees in them even so much as an approbation of the "popular article"; and is not improbably right. Outside one's own immediate province, it is much easier and pleasanter to read Science in the "popular article" than in the "original memoir." But perhaps after all this only shows that there is ample room for both. We certainly cannot dispense with the original memoir, be its "inexhaustibility" ever so great; all the more reason, therefore, why we should have journals like the present to supply the "entertainment."

And there is one kind of entertainment which can scarcely find its way into the original memoir at all, viz., what I have called at the head of this article "Scientific Anecdote." I hope that stories of scientific men and manners may often find their way into the *Illustrated Scientific News*; we scarcely get our fair share of them as yet, perhaps because Science is so comparatively new that it has not had time to accumulate traditions of the kind. And, again, it is, unfortunately for stories, the habit of the scientific mind to enquire mercilessly into the facts of any narrative; so that the few anecdotes which have come down to us are continually getting spoiled. Even a simple story such as that of Newton and the apple falling cannot escape; seeing how very mild the story is to begin with, one might have thought that it would be allowed to pass. But the ruthless commentator insists on pointing out to us exactly how unlikely it was that the falling of an apple influenced the course of Newton's speculations, and leaves us a mere wreck of an incident that can scarcely be expressed in words at all. There ought to be plenty of good stories of Newton and his times if only they had been preserved; why have only two or three doubtful ones come down to us? Is it that scientific men have been less human than others up to the present; and, if so, is it not high time that we set about correcting this fault? Let me in any case register a plea for scientific stories; and as a beginning, I will here reproduce two that were told at the meeting of the British Association at Belfast, in the Astronomical Section. They are given here not as being of any particular merit, but simply because they are the two I have heard most recently.

The first followed a paper read by Mr. Saunder on "Changes observed in the Surface of the Moon." It is a curious fact that, although those who have observed the moon most assiduously are unanimously of the opinion that sensible changes have taken place in certain portions of it, during the last century even, the moon is usually referred to by popular writers as an absolutely dead and changeless planet. Mr. Saunder gave a remarkably clear summary of the evidence for such changes, and showed how strong it was. In commenting upon his paper, the Chairman referred to an animated discussion, in years gone by, at the Royal Astronomical Society, upon the alleged disappearance of a particular crater on the moon; and he told us how the concluding words of one of the debaters had lived in his memory. "All I can say is," summed up this gentleman in emphatic tones, "that it wasn't there when I last saw it."

The second story followed a paper by Mr. Hinks on the Sun's Distance. We all know how the adopted value for the sun's distance has been changed from time to time with improved knowledge of the

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facts. A third of a century ago it was changed from 96 millions of miles to 92; and now it has been put about 93. There is no difficulty at all in measuring the distance roughly; the great difficulty is to get accuracy; and the progress towards accuracy is like the ascent of a mountain—we are always finding, when we think we are at the top, that there is a new summit above us. A few years ago, when one of these spurious summits had just been reached, certain gentlemen, in charge of Nautical Almanacs in different countries, met together in Paris, and decided that they would consider that summit as the actual top; and they altered all the Nautical Almanacs from the beginning of this present century accordingly. By the irony of Fate, a new summit of a very substantial kind appeared almost immediately. Mr. Hinks showed in his paper how strong the evidence now is for a distance of 93,200,000 miles; whereas a few years ago 92,900,000 was adopted as almost certainly within 100,000 miles of the truth. In comment upon this, another instance was quoted where it had been too hastily assumed that the truth had been arrived at. About 60 years ago the Astronomer Royal of the time wrote to the Superintendent of the Nautical Almanac concerning the value adopted in that work for the sun's apparent diameter. That value was derived from observations made many years before in foreign countries, and recent observations made with a better telescope at Greenwich gave a sensibly larger (or smaller, I forget which) value. The Astronomer Royal regarded it as not only unscientific, but unpatriotic, to persist in using the old value. The Superintendent replied very courteously, expressing his readiness to change the adopted value at once, if the Astronomer Royal would indicate what he thought the best new one to take; this information was supplied him, and the change was made. But the Nautical Almanac is always printed a few years in advance, and the new value did not come into operation at once. Before the annual volume was reached in which it first appeared, a better telescope still had been obtained at Greenwich; and when the diameter of the sun was measured with it a value was obtained sensibly agreeing with that which was just being discarded! Whether any further change was suggested the narrator did not tell us.

It is open to anyone to say that neither of these stories has any value from the scientific standpoint. They are not quoted, and the hope of hearing others is not expressed, with any very serious object in view. If there is an object, it may be best expressed in the words of the great man whose name occurs in the first paragraph. On p. 32 of Boswell's Journal, Dr. Johnson is reported to have said:

"Besides, I love anecdotes. I fancy mankind may come, in time, to write all aphoristically, except in narrative; grow weary of preparation and connection and illustration and all those arts by which a big book is made. If a man is to wait till he weaves anecdotes into a system, we may be long in getting them, and get but a few in comparison of what we might get."

H. H. TURNER.

Gold in Great Britain.

When one considers the experience gained in prospecting and the improvements made in the methods of extracting gold which have resulted from the keen competition in Australia, Canada, and South Africa, one sometimes wonders whether the little islands which we call our home have not been, perhaps, neglected by the prospector. That gold exists there is no doubt, and Mr. J. Malcolm Maclaren has lately given to the *Mining Journal* some interesting statistics with regard to it.

Among the tin mines in Cornwall and Devonshire, traces, and even occasional nuggets, of gold have been found. During 1852 and 1853 £581 5s. 1d. worth of gold was extracted from the Britannia and Poltimore Mines, near South Molton. Gold was discovered in North Wales in 1843, though only in small quantities, but from 1861 to 1867 the yield was very satisfactory. In 1888 new discoveries were made at Gwynfyndd, which have continued to be worked ever since, the amount extracted during this period being valued at £208,855, of which nearly one quarter was got in 1900.

In Scotland gold has been found during a great number of years. In the 16th and 17th centuries it was regularly worked at Crawford Moor, and it is variously stated the value of the gold extracted amounted to from £300,000 to £500,000.

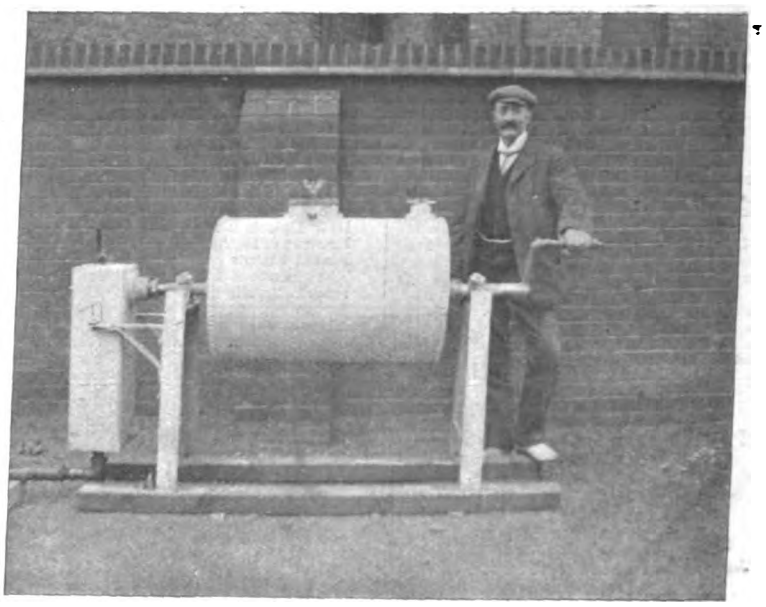
The gold deposits of the Kildonan, near Helmsdale, in Sutherlandshire, were discovered in 1868, and were worked more or less vigorously until the end of 1869. During this short period royalty was paid on £3,000 worth of gold, but as the temptation to conceal the greater portion of the gold discovered must have been irresistible, it is estimated that the total amount recovered by the diggers was not less than £12,000.

As regards Ireland, in 1795 the gravels of the Ballinvalley Stream, which flows into the Ovoca River, in County Wicklow, were found to be auriferous. A rush of peasants took place, and work was carried on for some weeks, when the Government took the matter up. Since then the valley has, off and on, been worked by the peasants and by various companies, and it is estimated that probably some £30,000 worth of gold has been obtained from the workings.

The Dry Generation of Acetylene.

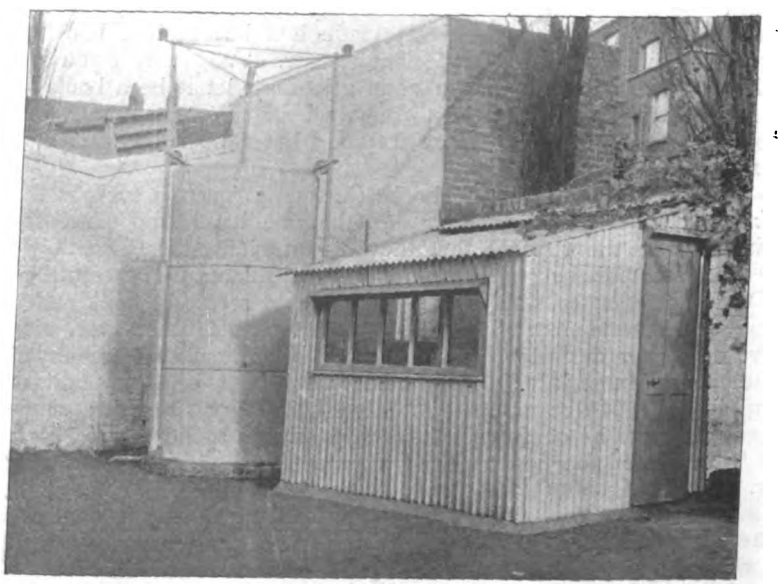
A Most Promising Industry.

In our last number we made a brief reference to the new method of producing this brilliant and healthy illuminant. We are now able to present some illustrations of the apparatus and give some further details, supplied by the inventor (Mr. G. J. Atkins) and the syndicate which is now placing the apparatus on the market. Whether the sanguine expectations of these promoters will be fully realized is impossible at present to foretell, but we can answer for it that the process, as demonstrated to us, gives the greatest promise of success.



Generating Apparatus.

The advantages of acetylene gas as an illuminant are well known. It possesses an extraordinarily high illuminating power, equalling about 50 candles per hour per cubic foot. It is economical, since 1 lb. of carbide, costing about £25 a ton, should yield 5 cubic feet of the gas, which is equivalent to coal-gas at less than 3s. per 1,000 cubic feet. The generating plant occupies very little space and costs but a fraction of a coal-gas plant of similar capacity, or of an electrical installation to produce a like illumination. It can be prepared without skilled labour, on the spot, and since only about one-fifteenth the amount of gas has to be consumed to give the same light as coal-gas, the heat and injurious products of combustion are very much less.



Complete Installation.

The chief disadvantages in the method of generating acetylene with water, as cited by the inventor of the new process, are—1. The liability to explosion, owing to the presence of phosphoretted hydrogen, which ignites spontaneously under certain conditions, and to the great heat which is generated by the hydration of the lime by water. 2. Great difficulty is experienced in regulating the rate of generation, the gas at first coming off with great rapidity, and getting slower as the carbide becomes coated with lime. 3. It is very seldom that the full amount of gas is got from the carbide, the yield rarely exceeding 4 cubic feet

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per pound. 4. The burners are apt to become clogged owing to the condensation of hydro-carbon vapours. 5. A light haze, due to the presence of phosphoretted hydrogen, detracts from the light. 6. The gas is unsuitable to the enrichment of ordinary coal or water gas, notwithstanding many trials. 7. It is not suitable as a motive power. 8. It has a peculiarly noxious odour. 9. It is impracticable to compress the gas for storage. 10. Purification of the gas is necessary, entailing extra apparatus and expense. The disposal of the residue, "an offensive, danerous, wet mass of lime and occluded acetylene," is a serious inconvenience.

These objections are, apparently, all overcome in generating by the dry process. As soon as the solid materials are mixed together, gas is generated with great regularity until every particle of the carbide is decomposed and the fullest yield possible of gas per pound of carbide is ensured. No phosphoretted hydrogen is given off, and the acetylene does not require washing or purification. The heat developed is very slight, so that the benzine and hydro-carbons are not developed. The residual products of decomposition left in the generator after the acetylene has been given off are comparatively odourless and perfectly harmless, and form commercial commodities with a marketable value varying according to the nature of the dry re-agent employed. The inventor has already employed a number of totally different materials. each of them producing different marketable commodities. In one instance the material used cost £2 a ton, and the residue resulting from its admixture with the carbide is said to have been superior to a similar substance now sold in England at £30 a ton! In fact, the system embodies the production of many common articles of consumption, giving off acetylene gas as part of the process of decomposition.

Instead of the extremely disagreeable odour, well-known to users of acetylene, got by the wet processes, this gas has an almost pleasant smell, sufficiently strong to enable leaks to be detected. The light is very constant and quite free from smoke.

This dry system should be specially applicable in many cases. For the lighting of railway carriages it should be greatly preferable to ordinary gas for many reasons. It is easily adaptable to light-houses and lightships, and being readily compressible, even by the mere force of its own generation, to a pressure of at least 200 lbs. to the square inch, should be invaluable for light-buoys. For searchlights and night signalling it should be very useful, considering the portability of the generating plant. It is possible for two men to carry apparatus for a light of 20,000-candle power. For photography its advantages are obvious, the light given being identical with sunlight. The gas obtained by this process is found to readily mix with ordinary coal-gas and greatly increase its illuminating power. But in addition to these great possibilities as an illuminant, there is a vast opening for this gas for motive power. Though it does not appear that a gas engine has yet been actually worked by this means, yet, when it is taken into consideration that this gas can be safely generated whenever required with simple and compact generators, that one volume of it mixed with 30 volumes of air does as well as ordinary coal or oil gas with 7 or 8 volumes, and that the high effective force of the explosion enables the use of smaller engines, there appears to be a great future before it.

The photographs show the installation at the works of the company in Walmer Road, Notting Hill, which are entirely lighted by the gas. The apparatus has been examined and passed by the chemist of the London County Council, and, as proving how satisfied he is regarding the safety of the system, special exemptions have been granted to the present regulations for the treatment of the residue.

One photograph shows the metal barrel into which the dry powders are poured, and, after being hermetically closed, this is revolved by the handle, and the gas is rapidly given off, and is conducted to the gas-holder. The other picture shows this gas-holder, and the shed within which is all the generating apparatus.

A Deep Sea Sounder.

A NEW device for ascertaining the depths of the ocean has been invented by Herr Bamberg. To the ordinary sounding line is attached a weight with a receptacle, closed, except for a fine capillary tube which enters it. When the apparatus has been sunk to a certain depth the pressure will be great enough to force the water through the small tube into the vessel, and the amount of water found in it will be a measure of the depth.

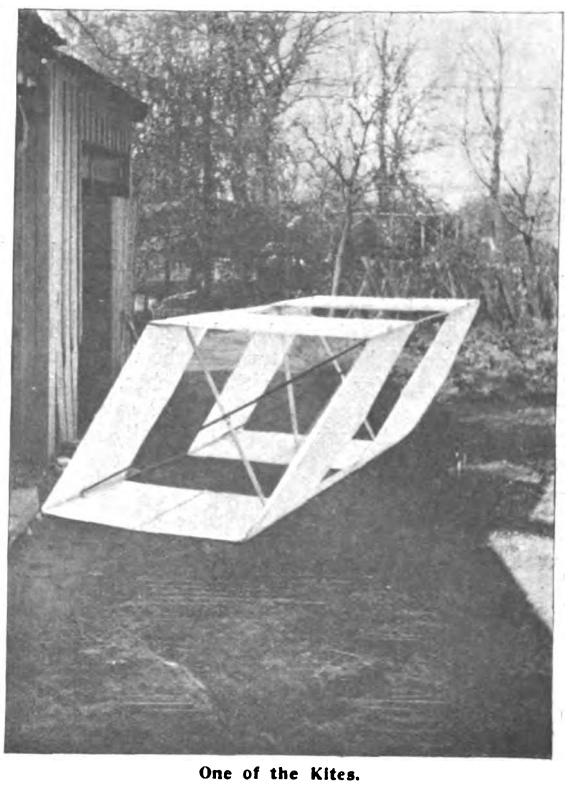
Distance of Nova Persei.

MR. W. E. WILSON lately read a paper in which he explained how the distance from the earth to the Nova Persei nebula could be ascertained if the variations in the surrounding nebulosity are due to the successive lighting up of the outer extensions of a previously existent nebula. Taking the velocity of light and the angular displacement of the nebulosity in a given time, the distance of the new star may be computed to be about 15,780,000 times the distance of the sun from the earth.

Sounding the Atmosphere with Kites.

AN IMPORTANT INNOVATION IN METEOROLOGICAL INVESTIGATION.

WHEN one realizes the great mass of the atmosphere that exists above our heads, the many wide strata of air of perhaps different densities and affected by different currents, the various cloud formations, one higher than another, extending miles up into the skies—when one thinks of all these and remembers how it is up there, and not upon the earth, that rain and snow are formed, that winds are strongest and most regular, that the electricity is generated which discharges as lightning to the earth, then one can understand something of the difficulties meteorologists have to contend with if they are only able to prosecute their investigations on the land at the bottom of this aeriform ocean. Instruments on the earth's surface must be greatly affected by local circumstances. Temperature must be dependent on the soil and surroundings. Wind currents will be distorted and moderated by trees, buildings, and protrusions of the ground. It is not often that the meteorologist can penetrate these upper layers. Mountain stations have been established, and much has been learnt from them. But even these are affected by the local considerations of their rocky surroundings. But little can be done on high towers, though such instances as the observatory on the top of the Eiffel Tower demonstrate most clearly how little we know of the upper atmosphere. On this exalted spot—though only 1,000 feet above the surrounding land



One of the Kites.

—it is found that the average wind force is three times as strong as it is at the ground level. Could we but have a number of such stations distributed about the country we should, with doubt, know much more about meteorology and be in a much better position to foretell the coming weather.

Occasional balloon ascents have also been the means of acquiring much knowledge, but the expense, risk, and practical difficulties in the way prohibit the regular employment of such means. Lately "sounding balloons," small unmanned gas balloons carrying self-recording instruments have been much used, especially in France and Germany.

But the method which has been found the most practicable and certain in its working is the employment of kites flown on a steel wire and raising automatically-registering instruments to a height of several thousand feet.

Though occasional experiments have been made by means of kites, from the time of Franklin onwards, the first really systematic installation was that at Blue Hill Meteorological Observatory, near Boston, U.S.A. Here, in 1894, the Director, Mr. A. Lawrence Rotch, set up a complete outfit of kites of various patterns, reels of steel wire, and a steam engine to draw the kites down.

The year after this the Weather Bureau of the United States officially adopted kites as part of the equipment of their observatories, and regular observations have ever since been conducted with most satisfactory results.

Since then more or less systematic kite-flying for meteorological purposes has been carried out both in France and Germany, but it was not until last year that anything of the sort has been done in Great Britain. A committee was then appointed by the British

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Association, and, acting in conjunction with a committee of the Royal Meteorological Society, a series of experiments have been made, and the report on these has now been published.

The committee consists of Mr. W. N. Shaw (Chairman), Mr. D. Archibald, Mr. C. Vernon Boys, Dr. A. Buchan, Mr. W. H. Dines (Secretary), and Dr. H. R. Mill.

For the preliminary trials, when there was a considerable risk of the kites breaking away and trailing long wires behind them, it was considered best to experiment in some thinly-populated district.* It was also desirable to compare the results of tests of the atmosphere at a height of about 4,000 feet with those recorded on the summit

A Kite and Reels of Wire.

of Ben Nevis, and for these reasons a suitable spot was selected on the West Coast of Scotland at Crinan, about thirty miles south of Oban.

The apparatus there installed consists of:—

1. *Winding-in apparatus* carrying two reels of 16 inches diameter and 4 inches broad to hold the wire, and two strain-pulleys to reduce the tension of the wire before it is wound. By suitable arrangements an adjustment of tension is obtained, and the risk of the reel being crushed by the tension of the many turns of the wire is avoided.

2. *The steam engine* for turning the winches, a necessity when several miles have to be wound in. This has 4 cylinders each of 2½ inches diameter and 4-inch stroke, and is nominally of 6-horse power.

Winding-in Apparatus.

The advantage of a steam over a petrol motor lies in the ability of the former to vary its speed according to the wind force, and thus the strain on the wire is better adjusted.

3. *The kites* are mostly of a modified Hargrave pattern, as shown in the illustration. Of these there are five, and two others of the Cody type have been procured.

4. *The wire* is steel piano wire of 1-32nd-inch diameter; a length of 8 miles in one piece has been supplied. Altogether 12 miles of wire are available.

5. *The instruments* are of the well-known Richard type, but a simpler type of instrument is being experimented with.

* It may be mentioned that on one occasion a pair of kites with a great length of wire broke away from the observatory at Berlin and travelled for nearly 100 miles across country, trailing the wire after them,

This complete apparatus has been in use every day when the wind is suitable, but there are many days when a sufficiently strong wind does not occur—a velocity of about 15 miles an hour is considered necessary, but it may be stated that experience in kite-flying with other forms of kites than those used certainly tends to show that a wind of much less force is required, and further trials will, perhaps, result in a lighter form of kite being used in light weather.

During June, July, and August, 72 flights were made to heights varying from 1,500 feet up to 12,000 and 14,500 feet. Great as this latter height is, which was attained on August 25th, it does not come up to the record of either France or the United States, both of which are about 1,400 feet higher.

The temperature gradient varied from 1.50 to 4.50 per 1,000 feet. The length of wire used was usually about double that of the height attained. One or two kites were most often employed, though occasionally three, and in the highest flight four were attached to the line.

In order to facilitate the raising of the kites in light winds, a steam tug was brought into requisition, and an ascent exceeding 1,000 feet was made every day that the tug was used. The regular speed of the steamer was 7 knots, though she could increase this to 8 for a short time. No difficulty was experienced in flying a single kite from the vessel in any weather that occurred, but with calms and light airs no great height could be obtained.

As regards the angle at which the kites flew, that depended, of course, upon the amount of wire out, since a long line acted on by the wind has a depressing effect. The following were the best results of angular elevation of the kite:—

36°	with 9,400	ft. of wire.
37°	,, 8,400	,,
38°	,, 7,500	,,
41°	,, 6,000	,,
51°	,, 5,500	,,
62°	,, 1,300	,,
62°30′	,, 300	,,

Volcanic Emissions.

The Causes of the Destruction of Life in St. Pierre.

When, on August 24th, 79 A.D., Vesuvius exploded and blotted out of existence the cities of Pompeii, Herculaneum and Stabiæ, it would seem that the principal agent of destruction was the torrent of pasty mud which flowed down the slopes of the mountain and overwhelmed houses, villages, and cities. This water lava as it has been called, was the joint product of condensed steam and volcanic dust. Herculaneum is supposed to have been destroyed in this way, though in the case of Pompeii it appears that it was the cellars and lower parts that were filled by this material. But in the case of the doomed city of Martinique, when the 35,000 inhabitants of St. Pierre perished on May 8th last, the agent of the destruction of life and property was in the volcanic cloud itself, which burst from the new crater in the side of Mont Pelée and overwhelmed the city.

The exact cause of the deadly effect of that fearful blast, which in about two minutes destroyed human life and animation of every kind and fired the buildings of the town, has been the subject of much conjecture and discussion. More than one theory has been proposed to account for the total destruction of life within the area of the ill-fated city. An ingenious hypothesis has been proposed by Professor A. E. Vessill. According to his views expressed in "Science," the chief factor in the destruction of life was the ejection of explosive gases from the volcano. He says, "The heat was sufficient to cause the dissociation of hydrogen and oxygen from the water on coming suddenly into contact with highly-heated lava, and in case of sea-water the chlorine would also be dissociated from the sodium. These gases suddenly ejected with great violence and exploding in the air above the crater would produce precisely the effects witnessed on an unusually large scale at Martinique. The people were mostly killed by the sudden explosion of a vast volume of hydrogen and oxygen, which will account for the sudden burning of flesh and clothes, as well as of the buildings and vessels. The chlorine at the same time combining with some of the hydrogen would produce hydrochloric acid, a poisonous gas, which would quickly kill most of those not instantly destroyed by the explosion." There is certainly some evidence in favour of the explosive violence. This has been contributed by Dr. Hill, of the U.S. Geological Survey. He was the first to set foot in the region of volcanic activity, and though he failed in his attempt to examine the crater of Mount Pelée, he witnessed from a point near the ruins of St. Pierre an eruption of the volcano of no little dimensions.

He thus describes the spectacle:—"Following the salvos of detonations from the mountain, gigantic mushroom-shaped columns of smoke and cinders ascended into the clear starlit sky, and then spread in a vast black sheet to the south and directly over my head. Through this sheet, which extended a distance of ten miles from the crater, vivid and awful lightning-like bolts flashed with alarming frequency. They followed distinct paths of ignition, but were different

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from lightning, in that the bolts were horizontal and not perpendicular." Dr. Hill considers these lightning-like bolts to be indisputable evidence of the explosive action of the gas after leaving the crater. He considers that they were a very important observation, explaining in part the awful catastrophe.

But though explosive action in the volcanic blast may have played some part in the loss of life, it is certainly not necessary to have recourse to such a theory to explain the general destruction of life, if we consider the other circumstances which attended the outburst of the volcanic avalanche.

The probable cause of the whole destruction of life was clearly stated in a letter by Dr. Nicholls, of Dominica, and which was published by "Nature" in an article on the West Indian volcanic eruptions, June 26th.

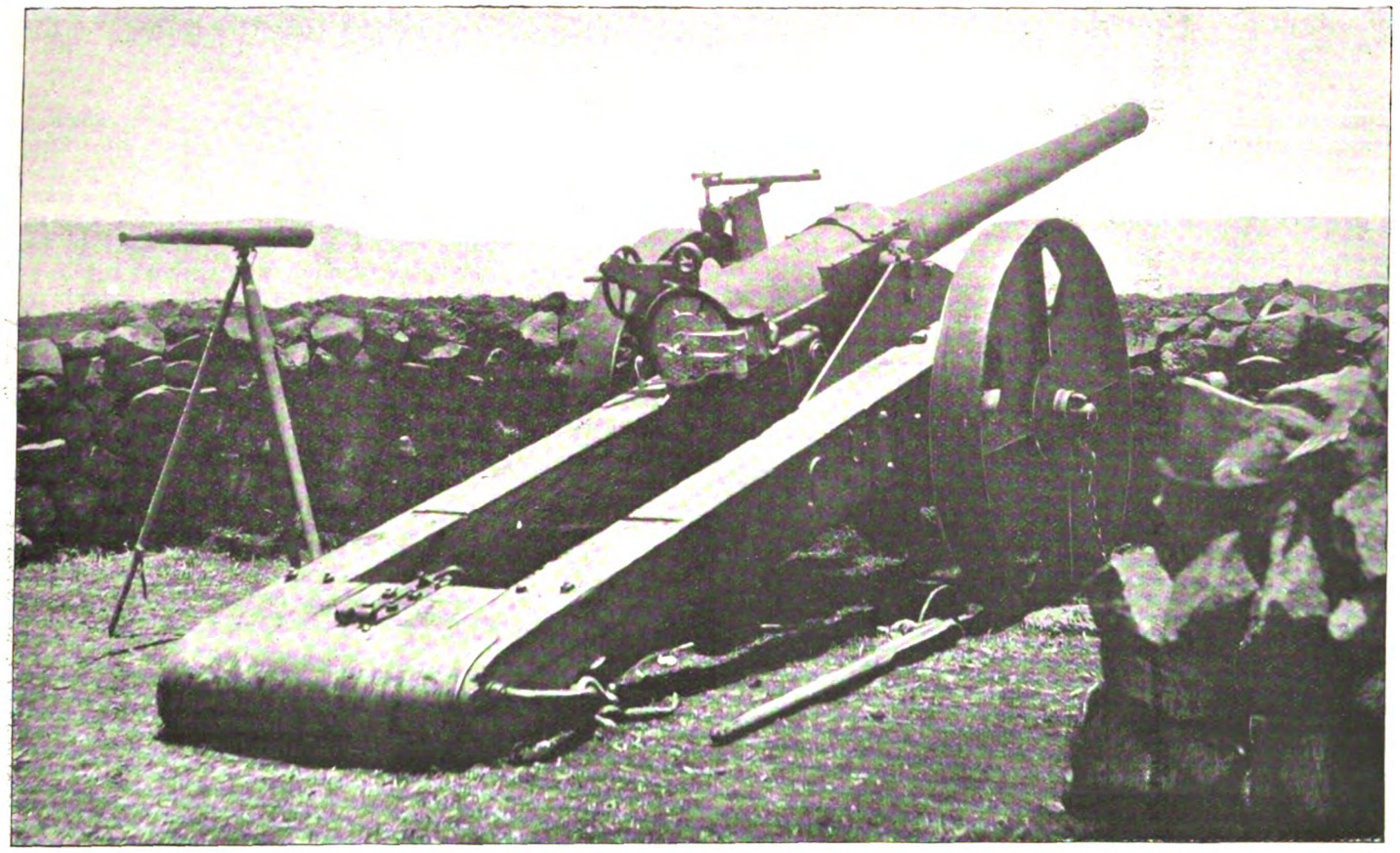
"The eruption came suddenly and unexpectedly, and probably in a few minutes the 35,000 persons in the city of St. Pierre were corpses. It would appear that a sudden fissure was opened on the side of the mountain overlooking the city, and near to the Etang Sec on this flank of the volcano a large vent belched out lava, superheated steam, and acid gases downwards on to St. Pierre and the roadstead. The flashing-off into steam of the water imprisoned in the incandescent lava converted that lava into sand and dust before it reached the city and the radiation of heat from molten rock at a temperature of above 1,000°C. caused an incredibly hot blast that would create a red-hot hurricane—if I may employ such a term—that would kill people and animals instantly, and that would cause all inflammable matter to burst into flame. This, from what I gather, is what really happened, and I do not think that poisonous gases or electrical phenomena are accountable for the destruction of life. You can imagine what is the enormous heat right over the vent of an active volcano. Well, St. Pierre, practically, for a short time, was in such a position, the vent being directed laterally towards the city until the fissure was closed and the volcanic ejections were again directed vertically upwards. Many persons were actually burnt in places by hot scoriæ and mud, but the blast of heat from the volcanic vent appears to me to account in the only satisfactory way for the details I have obtained of the conditions found in the living and the dead."

It will be noticed that Dr. Nicholls lays stress on the suddenness of the disaster. It is no doubt due to the suddenness that there was escape for no one. Had there been but a few moments' warning of the impending calamity, some might have had resort to cellars where available, and thus escaped.

The Royal Society's report on the West Indian eruptions quite supports the opinion of Dr. Nicholls, but it mentions that though the chemical constitution of the gases contained in the blasts from the volcanoes in both Martinique and St. Vincent is as yet unknown, still there are many reasons which make it unlikely that they contain much oxygen, or can support respiration. Since the publication of the Royal Society's Report, however, in a paper on the eruption of Martinique, read before the Paris Academy by MM. A. Lacroix, Rollet de L'Isle, and Giraud, the opinion was expressed that there was no doubt that amongst the gases present in the volcanic cloud was sulphur dioxide. In the presence of this gas, therefore, would be death by suffocation, even apart from the aggravated circumstance of the finely-divided and incandescent sand and ashes. In the above-mentioned report there is a remarkable instance cited of the preservation of life by diving in St. Vincent during the passage of the volcanic cloud. These fortunate survivors were the occupants of a boat which was near Richmond, when the blast swept down from La Soufrière. It is stated that these persons dived into the water to escape the deadly avalanche, that on returning to the surface the air was still suffocating, but they continued to dive over and over again until they were at their last gasp, when, once more tasting the air, they found it was cleared and breathable.

It is stated that the positions in which some corpses were found in St. Pierre testify to the sudden deprivation of life. Some persons were found seated at table. One man had his legs and arms fixed in the position of a runner. If such cases can be absolutely verified they would seem to be in favour of the theory that in some cases the lightning discharges in the cloud effected death with even greater swiftness than the white-hot particles of matter or the suffocating gas. Though much light has been thrown on the disaster by the researches of the Royal Society's Commission, the subject still demands continued investigation.

(Signed)
ERIC STUART BRUCE.



Gun mounted on makeshift Carriage.

The 4.7 Gun.

THE return of H.M.S. *Terrible* after her adventurous voyage, or, rather, after the voyage in which many of her crew found adventure, for the ship herself took no part in the wars either of South Africa or China, has brought renewed interest to the question of large guns in field operations. The story of the Boers taking heavy ordnance about the country in a manner which was quite a surprise to European experts is too well known to repeat, and the counter-stroke of our handy-men in rigging up some large naval guns and dragging them over the veldt was a fine exhibition of the resources and resourcefulness of the British nation. We reproduce here, first a photograph of a 4.7 gun mounted on Captain Percy Scott's carriage, a cumbrous makeshift, but thoroughly serviceable. This was the form of gun that the Blue-jackets of the *Terrible* dragged to Ladysmith, and of others that were taken to Modder River and Bloemfontein. The next view shows the development of this experiment, the same class of gun mounted on the new field carriage made in England for the use of the Royal Artillery.

Though most artillerists would have supposed that it might be possible to draw such huge guns slowly along well-made roads, it has been a matter of satisfactory surprise to find how, in practice in South Africa, they have been dragged about over the worst of roads and under the most unfavourable conditions. The third picture shows a typical instance. Often as many as 32 oxen were employed as a gun team, but the instances were few in which any great delay was occa-

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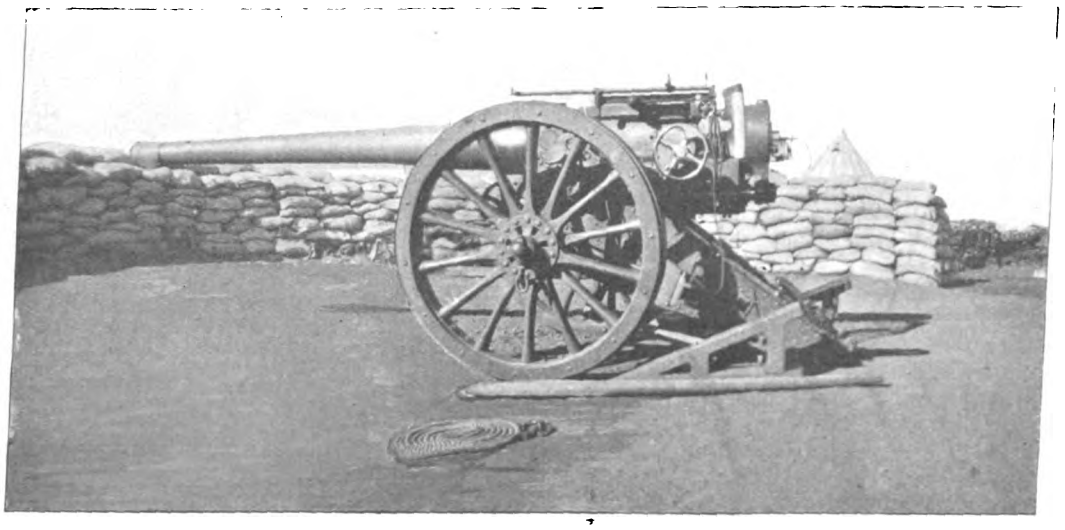
sioned by the wheels sticking in mud or other obstructions. One of the most curious instances of what may have appeared an insurmountable obstacle being successfully overcome was when a wide and much-swollen river had to be crossed. The gun was too heavy to be taken on the pontoons by which other goods were ferried over, and it seemed as if the water was too deep to be forded. However, the oxen having swum across, a long chain was carried across the river, and the team, by this means, drew the gun across on the bed of the river, the gun itself entirely disappearing, temporarily, below the water, but reappearing safe and sound on the far bank.



Gun on New Field Carriage.

4.7 Gun being taken across Country.

Ferro-Concrete Construction.

AT a meeting of the Society of Engineers held at the Royal United Service Institution, Whitehall, on Monday evening, October 6, 1902, Mr. Percy Griffith, President, in the chair, a paper was read on "The Hennebique system of Ferro-Concrete Construction," by Mr. Augustus de Rohan Galbraith.

The author commenced by observing that ferro-concrete construction appeared not to be very widely known in the profession. He then sketched the early history of the system, pointing out that the first authenticated adoption of the principle was by Napoleon the Great in the erection of fortifications near Strasburg in Alsace-Lorraine, towards the close of the eighteenth century, and in which works hoop iron bonding in concrete was employed.

He then referred to the various systems of ferro-concrete construction, stating that the originator of the principle was M. Joseph Monier, a Frenchman, and that it was first applied to the manufacture of slabs and pipes in ferro-cement. He then described the ferro-concrete system invented by M. Hennebique, a French engineer, which system has been widely introduced in practice in France, including the construction of a bridge of three arches at Chatellerault, 26 ft. 3 ins. wide, and having a centre span of 172 ft. and two side spans of 135 ft. each. This system is also being adopted in this country in various engineering works, notably in connection with the old quay widening and new dock works of the London and South Western Railway Company at Southampton.

The Hennebique principle consists in embedding in concrete straight and cranked iron or steel tension bars and stirrups, to take the shearing stresses, together with distance pieces, the system being applicable to, and employed in, entire buildings from foundation to roof, inclusive. The piles used at Southampton are built up in vertical moulds, in which are placed long steel rods, which give the required strength. These are laced together with wire stirrups, and Portland cement concrete of the best quality is filled into the moulds and rammed round the steel. After a month the pile is taken out of its mould and driven in position, much in the same way as timber piles are. The ram is exceptionally heavy, generally 30 cwt. The head of the pile, is protected from injury by covering it with a helmet, or iron case, filled with sawdust; a timber dolley is always used.

The author then pointed out the care required in the selection and preparation of the materials, explaining that the usual proportions of the concrete were 5 to 1, and giving the preference of Siemens-Martin steel to Bessemer steel owing to the purer and more uniformly good quality of the former. He then dealt with the application of the system in general construction, giving the results of some tests of Hennebique beams with and without stirrups, which proved the superior strength of the former. He then stated that the results of experiments by Professors Baushinger and Ritter showed that the adherence of iron to concrete was about 570 lbs. per square in. The co-efficient of expansion and contraction of steel and concrete was found by M. Durand Claye to be identical up to the fifth decimal, giving the breaking strain of concrete as between 3,000 and 4,000 lbs. per square in.

The advantages of the system as regards fire resistance were then illustrated by the light of some severe fire tests carried out at Ghent, together with the results of a fire which occurred at a spinning mill at St. Etienne, Belgium, which proved that ferro-concrete structures were perfectly fireproof.

The author then gave the following examples of the cost of the Hennebique system as carried out in different structures: The Chatellerault Bridge £18 12s. per lineal foot; a grain warehouse at Plymouth 4½d. per cube foot of space; a flour mill at Swansea 4¼d. per cube foot; grain silos at Swansea 6¼d. per cube foot, and some coal hoppers at Portsmouth 7¼d. per cube foot.

In conclusion the author referred to the development of the ferro-concrete system on the Continent, owing to which the French Government recently created a special department at the Ministry of Public Works to take into consideration all matters relating to that principle of construction. He observed that although the system had not hitherto made very great headway in England, its advantages were becoming recognised and its adoption was increasing.

The Strength of Ants.

THE marvellous strength exhibited by insects has frequently been commented upon. Their powers of running, of hopping, of weight-lifting and weight-drawing seem altogether out of proportion to their size. A recent observer happened to notice a grasshopper moving slowly on the road, but on closer inspection found that it was not alive, but that the comparatively huge corpse was being dragged along by a tiny ant. Out of curiosity he took the specimens home and carefully weighed them. The ant scaled 3.2 mg., while the grasshopper was as heavy as 190.0 mg., that is to say, nearly 60 times the weight of the minute beast of burden. If a man of 150 lbs. weight could move along a mass of the same proportion it would weigh something like 4½ tons! And this dragged over rocks often as big as himself, for such would be the relative size of the grains of sand on the road.

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The de Bradsky Navigable Balloon.

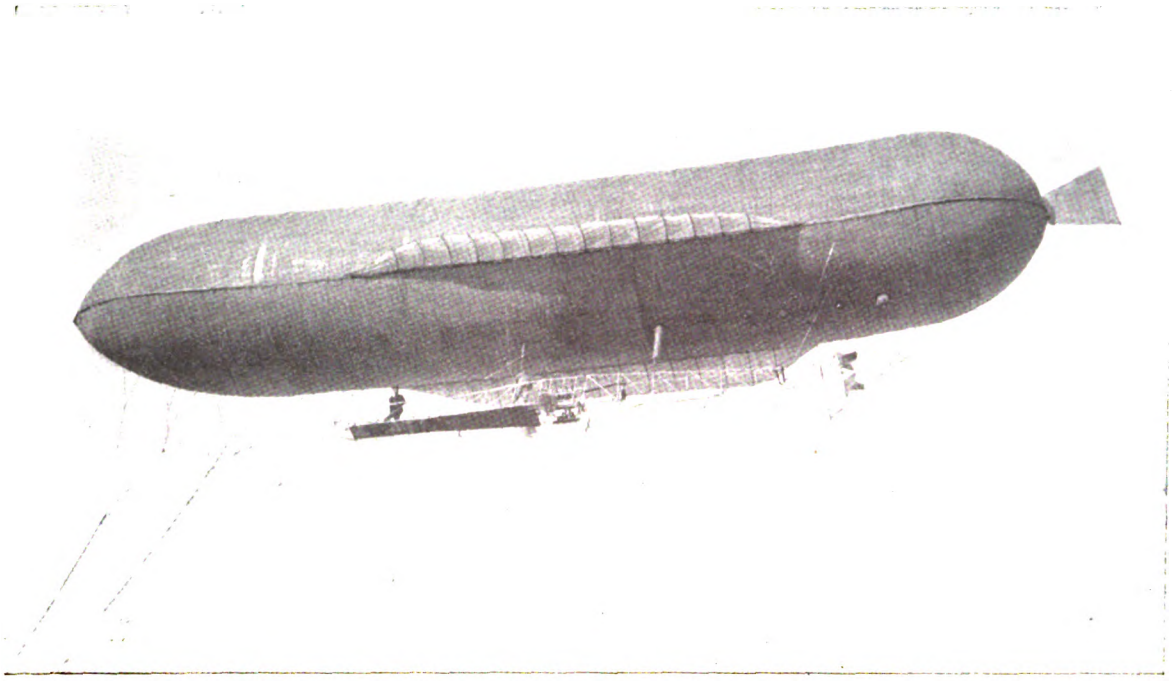
If M. Santos-Dumont has done nothing else by means of his aerial demonstrations, he has certainly opened the eyes of the world to the possibilities and to the formidable difficulties that may result from the navigation of the air by propelled balloons. He has encouraged a host of others to try their lot and endeavour to surpass him with their new-fangled craft. It seems unfortunate that so little success has attended their efforts. We in London have seen a vessel, somewhat on the same lines as his, but with an utterly inadequate engine-power, wafted before the breeze and quite unable to stem it. Now we hear of two airships in America, one being actually of Santos-Dumont's build, both of which were carried away from their starting point and unable to regain it. And, finally, news comes of Baron de Bradsky's futile attempt to stem the breezes, after waiting for some weeks for a favourable day for the trial. Most unfortunately, too, like his predecessor, Senhor Severo, this poor inventor, with his companion, has fallen another martyr to the cause of aerial navigation.

But every repulse teaches us a lesson. The more severe the repulse the more is the lesson impressed upon us. It is, therefore, the duty of those, and they are many, who hope to pursue and further this subject, to study the facts and learn the lessons.

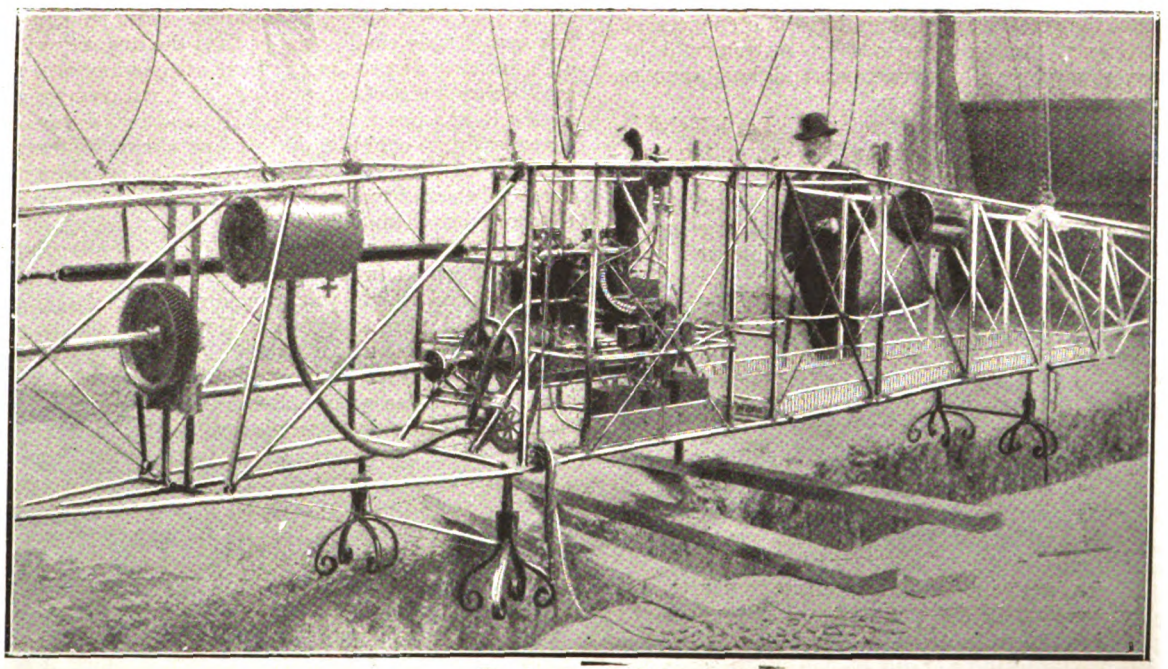
The machine was not very dissimilar to the many others that have now been constructed. An elongated balloon, 110 feet long by 19 feet in greatest diameter, supported a long framework carrying the aeronauts, the engine, and the screw propeller. For a certain distance along each side of the gas-holder, fin-like wings were attached.

The apparatus was practically identical in size and motive-power with that of the "Santos-Dumont V." The cradle or car was constructed of steel tubing, was 56 feet long, and weighed in all some 770 lbs. This was suspended from below the balloon by means of steel wires, these offering less resistance to motion through the air than would hempen ropes. But there appears to have been some miscalculation on this point, as it seems that the accident was due to the breaking of these wires.

As with Santos-Dumont's machines, the vessel was so balanced as to be incapable of rising in the air through the buoyancy of the gas alone, but rendered so light that the revolutions of a screw propeller should cause it to rise. In this instance a special propeller for this purpose was mounted on a vertical shaft. This idea is not new (as some accounts have stated), having been applied to the balloon in which the late Dr. Woelfert came to such terrible grief some years ago. In the photograph of the car which we reproduce, this screw is not in place, though its shaft may be noticed protruding below the car underneath the engine. The floor is raised on four spring legs to prevent the screw resting on the ground. In the photograph of the machine in the air, this vertical propeller is represented by the dark blur underneath the car, it being at the time in rapid rotation.



The de Bradsky Navigable Balloon.



The Car and Engines.

The motor was a petrol engine of 16-horse power, geared to a propeller 14 feet diameter, causing it to revolve 350 times per minute. This propeller was placed aft, not forward as in many other airships. A vertical rudder was fixed on to the end of the balloon in line with its axis.

On the day in question an ascent was effected at 7.30 a.m., but the S.W. wind proved too strong, and despite the working of the propeller

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the balloon was carried away towards Montmartre. At 9 o'clock, when close over Stains, the aeronauts shouted to some labourers, evidently intending to make a landing. M. Morin, de Bradsky's companion, was seen to move along the platform, which action seemed to upset the balance of the whole machine which commenced pitching, and almost immediately afterwards the whole framework of the car was seen to break away from the balloon and fall to the earth, both occupants being killed on the spot.

It is said that the ends of the wires were rolled into spirals, presumably to lessen shocks, though these only formed weak spots. But what led these to break at that particular moment, or, indeed, if this was really the cause of the disaster seems, unfortunately, quite uncertain. It seems, however, that the two occupants of the car were both inexperienced as balloonists, and should certainly not have trusted themselves alone on an aerial voyage until they had gained some practical insight into the ways and behaviour of balloons.

B. B.-P.

Lord Kelvin.

G.C.V.O., LL.D., D.C.L., F.R.S., P.R.S.E.

The name of Lord Kelvin is so well known, and the fame of his many achievements in practical science so widespread, that it seems almost superfluous to publish a short account of his career. Nevertheless, there may be facts forgotten by some that it is as well to be reminded of. William Thomson was born in Belfast on June 26th, 1824. His father, Dr. James Thomson, was Professor of Mathematics in the Glasgow University, and he himself was educated there, and has been associated with that institution ever since. He was afterwards at St. Peter's College, Cambridge, where he graduated as 2nd wrangler, and was 1st Smith's prizeman in 1845. When only 22 years old he became Professor of Natural Philosophy in Glasgow. In 1857 he was appointed electrician to superintend the laying of the Atlantic cable. It may be remembered how this was started with a ceremonial inauguration by the Lord Lieutenant of Ireland at Valentia; how the massive cable was taken on board the *Agamemnon* and the *Niagara*, and paid out to the extent of over 300 miles, when it snapped under the strain of the Atlantic swell. Other attempts failed also, but on 5th of August, 1858, the cable was laid and communication opened with America, though only for a short period, and the project was temporarily abandoned. In 1865 the *Great Eastern* was employed in laying the new cable, and after many vicissitudes, finally succeeded. The special instruments which had to be used in this novel work were designed by Professor Thomson.

The extremely feeble electric current resulting after the passage through so great a resistance would have been hardly detectable, but Thomson formed a delicate instrument by fixing a small magnetic needle to the back of a very light mirror suspended by a thread, which showed the slightest movement by the reflection of a pencil of light on a distant screen.

In commemoration of the great event of the telegraphic connection between the two continents, the six persons most instrumental in accomplishing it were rewarded with baronetcies and knighthoods, among the latter being Sir William Thomson.

It would be quite impossible here to recapitulate all Lord Kelvin's inventions, for their name is legion. One of the best known, perhaps, is the deep-sea sounding apparatus, consisting of a coil of fine steel wire, miles in length, to which is attached a weight with appliances for registering the depth, and so arranged as to bring up a sample of the bed of the ocean, and thus often enable mariners to ascertain their position on the chart. Marine navigation has greatly benefited by other inventions of his as well; the improved compass is well known, the tide guage, and many others. Electrical devices for many different purposes have also been invented by Lord Kelvin, indeed, it may be said that no individual has done more than him to bring electricity to the position it now holds in industrial economy.

But Lord Kelvin is not merely an inventor—he is a philosopher as well, and his scientific writings are said to number over three hundred. His theories on heat and motive power have brought him a world-wide reputation. As early as 1848 he "drew attention to the great principles underlying Carnot's work on the 'motive power of heat,' and applied them to an absolute method of temperature measurement, which is completely independent of the properties of any particular substance." And this led to the adoption of the present absolute zero.

In 1862, in conjunction with Joule, Lord Kelvin made some important experiments on the thermal effects of fluids in motion. In 1890 he was selected as Chairman of the International Niagara Commission. He has been President of the Royal Society, was four times elected President of the Royal Society of Edinburgh, and in addition to the Victorian Order holds the Order of Merit.

Lord Kelvin has been the recipient of a vast quantity of honours from all parts of the world, including the Prussian Order Pour la Merite, Grand Officer of the Legion of Honour, Order of 1st Class Sacred Treasure of Japan, and many others.

He has been married twice, the present Lady Kelvin being a daughter of Mr. Blandy, of Madeira.

Becquerel Rays and Radio-activity.

In a recent lecture, Professor J. J. Thomson gave a very interesting account of the discovery and nature of these mysterious rays.

Professor Thomson described how Professor Becquerel, of Paris, took a quantity of a salt of uranium and placed it near a photographic plate, protected from light by suitable screens, and kept the uranium in a state of phosphorescence by continued exposure to sunlight. On developing the plate after the experiment had lasted for several hours he found a picture upon it, showing that something similar to Rontgen rays had been given out by the uranium. In all the earlier experiments the uranium was kept exposed to the sunlight and was thus phosphorescing during the whole time of exposure. It happened, however, on one day that the sky clouded over during the experiment, and there was not light enough to make the uranium phosphoresce. Becquerel put his apparatus away and waited for better weather. The weather, however, did not improve, and Becquerel developed his plate, expecting to find a feeble picture. To his surprise he found that the picture excelled all those he had previously taken, proving that the uranium emitted the rays even when it was not phosphorescing. This radiation was similar in penetrating power to that of the Rontgen rays, and Becquerel at first thought that his rays, like ordinary light, were capable of being refracted, and that they could be polarized. This had been proved to be not the case. Becquerel rays were, in fact, a mixture of Rontgen and Cathode rays. Evidence had been given to show that the Cathode rays consisted of exceedingly small particles, called corpuscles, smaller than the atoms of any known substance, and moving at the rate of many thousand miles a second, the speed depending upon the extent to which the air had been removed from their path. Large as the velocity was, it was greatly exceeded by the velocity of the Cathode rays given out by uranium, while another substance, radium, emitted rays moving at a still greater speed, velocities of over 120,000 miles a second having been recorded by Becquerel in this case. Among all the mysteries associated with matter, few, if any, were more startling than that afforded by these substances, in no way remarkable in appearance, which, without provocation and without intermission, emitted properties which travelled at a rate compared with which that of the fastest bullet was absolutely insignificant. If artificially prepared salts of uranium were examined, it was found that the activity was strictly proportional to the amount of uranium they contained. M. and Mme. Curie found, however, that several native minerals, and especially pitchblende, although only a fraction of their bulk consisted of uranium, were much more active than pure uranium; one of these minerals, chalcolite, was prepared artificially, and the activity of the product was found to be normal—that is, proportional to the amount of uranium contained. It seemed probable, therefore, that these minerals contained some unknown substance much more active than uranium itself. M. and Mme. Curie applied themselves to the task of separating this suspected substance. They found that a very radio-active substance, which has been called polonium, was connected with the bismuth taken from the pitchblende, and also another substance named radium. A third substance had since been obtained, which seemed closely to resemble thorium, and was known as actinium. The amount of these substances was exceedingly small, smaller than the quantity of gold in sea water. The property of producing electrical conductivity in gases afforded a most delicate test of the presence of a radio-active substance. By this means it was possible to detect quantities of the material millions of times less than could be detected by chemical analysis, and thousands of times less than could be shown by the spectroscope; indeed, of the three substances mentioned, radium was the only one that had been detected by chemical or spectroscopic means. By successive purification of the barium obtained from pitchblende, radium had been obtained, which was more than 100,000 times more active than uranium, and which, when enclosed in lead one quarter of an inch thick, could produce greater effects than uncovered uranium. The radium made a sensitive screen phosphoresce; it showed the bones in the hand; and was so vigorous in action that it had produced sores on the skin of those who had incautiously handled it; and it emitted negatively electrified particles with a velocity approaching that of light. This continual emission implied that the radium was losing mass and energy, but the loss of mass would amount to only about one thousandth of a millegramme in a million years for each square centimetre of surface. But the amount of energy radiated was quite appreciable, being sufficient, if converted into heat, to melt in a million years a layer of ice of the same area as the radium, if more than a quarter of a mile thick. Loss of energy has been going on, it might be, for millions of years, ever since the radium existed. There must have been, therefore, a very considerable store of energy at the outset, and a very interesting question was the nature of this energy and how it was stored. Professors Rutherford and Soddy had given a satisfactory answer to this question by their experiments on the substance thorium, from which they had been able to separate its active constituents, obtaining two products, one minute in quantity, but intensely active (thorium X), the other, which contained practically the whole of the thorium, almost inert. This arrangement, however, did not last long. Thorium X began to lose its activity, and the mass of thorium to gain it. After a few days thorium X became quite inert, while the thorium regained its old activity, and afforded fresh supplies of the thorium X. Ordinary thorium was thus steadily being trans-

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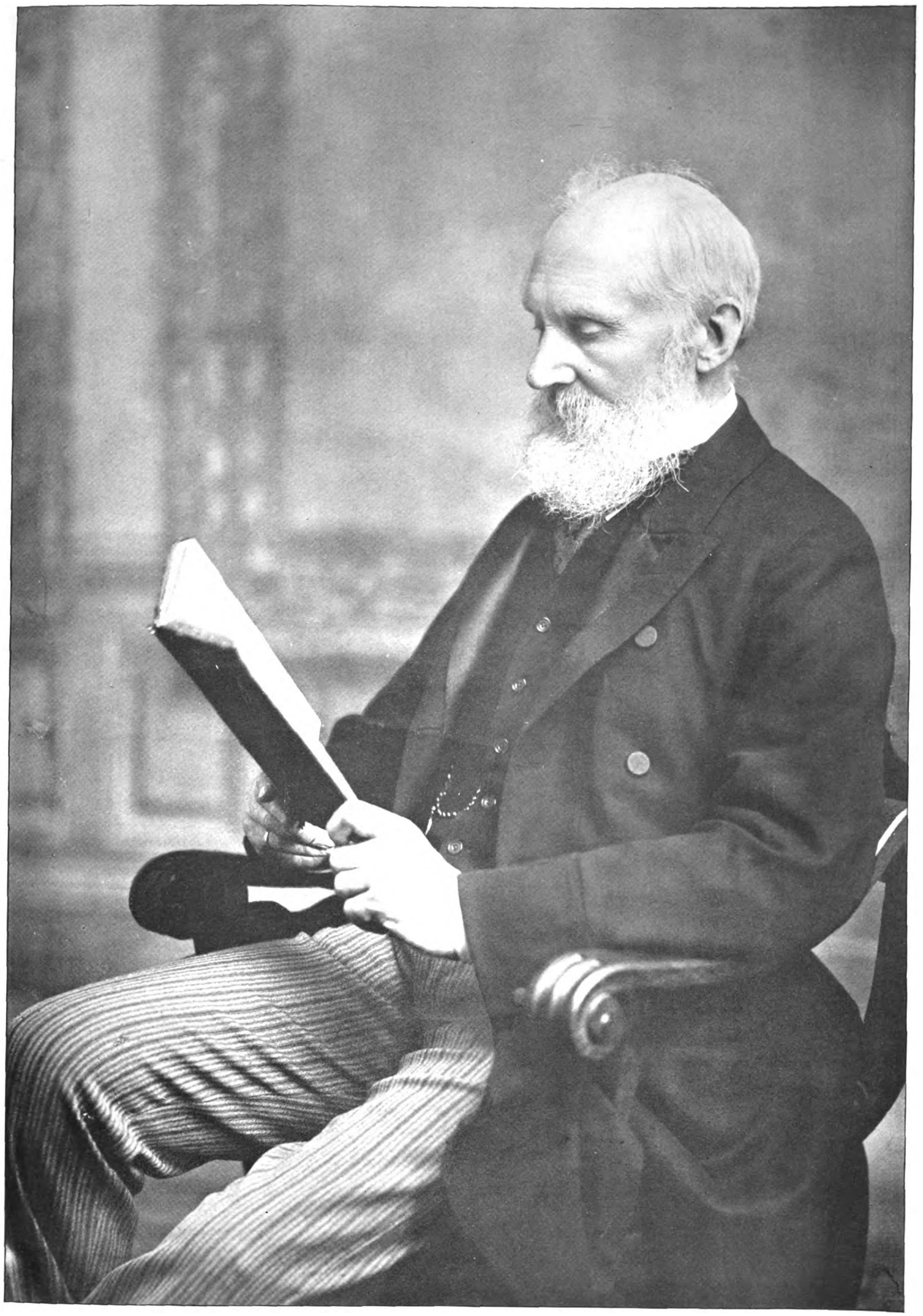

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LORD KELVIN,

G.C.V.O., LL.D., D.C.L., F.R.S., P.R.S.E.

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formed into the active thorium X, while this is continually passing into some inactive form; what this inactive form was we did not know, and its elucidation offered a most interesting problem, rich in possibilities. Rutherford found that thorium, besides giving out Rontgen and Cathode rays, gave out a radio-active gas, which he called the thorium emanation. The activity lasted only a few minutes, and was given out only from the thorium X, and not from thorium in its normal state. This emanation resembled the new gases argon and helium in its refusal to combine with any other element. It was remarkable that the minerals in which helium occurred invariably contained radio-active substances, and the idea naturally suggested itself that helium might be very closely connected with the gaseous emanation from thorium X. Radium gave off an emanation more permanent than that of thorium. Radio-activity could be induced. If the substance was negatively electrified while in contact with the emanation, the radio-activity induced in it was very much increased. The intensity of this induced radio-activity did not depend to any great extent on the nature of the substance. A piece of paper could be made as radio-active as a piece of metal, but the property was not permanent, lasting for a few hours only. Elster and Geitel had made the remarkable discovery that substances could be made radio-active without the aid of thorium or radium, all that was necessary being to hang them up in the open air, and charge them strongly with negative electricity. The earth itself was negatively electrified, and the natural electrification on pointed conductors connected with the earth was sufficient to make them radio-active. The pointed leaves and spines of trees were always radio-active, and Mr. C. T. R. Wilson had lately shown that freshly fallen rain possessed this peculiarity and retained it for about half an hour. It had been suggested that this induced activity pointed to the presence of another undiscovered constituent in the atmosphere but experiments were described which showed there was no necessity for this hypothesis. The production of radio-activity in all bodies might be thus explained. The air always contained small bodies called ions, some charged with positive, others with negative, electricity. When a negatively electrified body was placed in the air the positively electrified ions were attracted towards it. Some gave up their electric charge, but those that did not would accumulate close to the surface of the body, forming a layer of positive electricity round the body. This layer would attract the negative electricity in the body, and when the attraction was very great the negative electricity would be pulled so vigorously that it would shoot out from the body with great velocity, approaching that of the Cathode rays, and hence would give out Cathode rays and be radio-active. It was in this way that the leaves of trees, and the countless objects on the surface of the earth acquired radio-activity and, becoming in fact Cathodes, discharged those rays, which had only comparatively recently been discovered by the help of the most elaborate apparatus and yet were in all probability so widely distributed and so frequent that there was hardly a patch of ground on the earth's surface which did not contain a source of these rays.

Air Purification.

A New Method of Rendering Bad Air Breathable.

In our last number reference was made to properties of peroxide of sodium in purifying air by absorbing carbonic acid. Our attention has been called to a recent article in the *New York Sun*, which throws further light on this subject, as the following extracts show:—By the merest chance two French doctors Desgrez and Bolthayard, have recently made the important discovery that bioxide of sodium will purify and repurify air indefinitely. This means, roughly speaking, the removal of chief obstacles to submarine work, and to all other pursuits requiring a constant renewal of air by mechanical means. Its commercial value along many lines can hardly be estimated. To the credit of several mice, forgotten and left to die, the discovery must be credited. In the laboratory of the two chemists the mice had been placed for some experiments in a closed glass globe, and then forgotten. In the nature of things the air of the globe should have been soon exhausted, and the mice have perished of asphyxiation. Great was the surprise of the two chemists, therefore, when, several days later, they found the mice still alive. Somewhat thin to be sure, but exhibiting no difficulty in their breathing. Casting about for an explanation of the mystery they decided that a small block of bioxide of sodium which had been left in the globe must have effected the unexpected prolongation of life. They tested the matter. Rabbits and dogs were shut up with a block of the bioxide of sodium in hermetically sealed glass receptacles just large enough to hold sufficient air for half an hour or so. After five hours and a half the animals were still breathing regularly and placidly, just as if they were in the open air. Then it was decided to experiment with human subjects. A diver's helmet was constructed with a lining of the bioxide of sodium. The air capacity of the helmet was only about five pints. But the air being purified and oxygenized by the action of the chemical, the wearer was able to remain under water for an indefinite period. There was no longer any room for doubt that a discovery had been made, which, while of extraordinary simplicity, will be an invaluable aid to progress, and to the comfort of life. It was shown by experiments that wherever carbonic acid gas is present bioxide of sodium fastens on it. Incidently a proportionate quantity of pure oxygen is set free—that is to say, the bioxide of sodium is the most efficient scavenger of vitiated air yet discovered. It needs no preparation of any kind, its mere presence suffices, and it is absolutely insatiable, as long as there is a morsel of the bioxide left, and the tiniest whiff of carbonic acid gas for it to play on, it continues its purifying work. The uses to which the bioxide may be put are endless, it will be used to purify the air in hospitals. Mining operations will be rendered much more safe by its use. Crowded factory rooms can be kept always full of fresh, sweet air. In theatres, ball rooms, and places of public meeting people can breath freely. In schools children will be brighter and healthier for its presence. It has been pointed out also that the bioxide will dispense with the need of opening windows in winter time. Instead of losing three-quarters of the artificial heat of our rooms through windows opened for ventilation, we may, if we like, keep our apartments hermetically closed from November until May, and have a constantly equable temperature, with no fear of sudden chill, the air, none the less, always perfectly pure, and the coal bills cut down. More interesting still is the suggestion due to the discoveries that bioxide may be used to give people a chance who are buried alive. Dr. Desgrez especially is enthusiastic on this point. He insists that the law should compel the construction of what he calls scientific coffins, spacious enough to give ample turning-over room, having a bell attachment ringing outside, and containing a block of the bioxide. Apropos of this comes the question as to whether the harm of vitiated air is due to its impurity from a chemical point of view or from the germs which may inhabit it. On this point an "eminent bacteriologist" has given his opinion. "Personally, I think *bad air* is injurious not so much because of germs it may contain, as on account of its lowering effect on the system. There is the opportunity of evil-disposed germs! Seaside and mountain air act beneficially, not by reason of the germs or otherwise, but because the ozone benefits the system, which is then able to withstand the onslaught of injurious bacteria. It is not, I think, a question of germs, but of carbonic acid gas in bad, and oxygen in good air—the former of which affects the lungs and the system generally, and favours disease bacilli if they happen to come that way." Nature's allowance of carbon dioxide, as it is called now, is four parts in 10,000. In what would be considered a well-ventilated room it amounts to 50 or 100 per cent. more than this; in one ill-ventilated it amounts to enough to poison every breath.

Invisible Colouring for Guns, Uniforms, and Ships.

The trial of painting guns rainbow-colour, that is, in stripes of red, blue, and yellow, appears to have been considered most satisfactory at Aldershot. The idea is by no means new, at least as regards a colouring which should be as inconspicuous as possible. Many years ago the subject was mooted in the Service papers, where it was pointed out that a man dressed in parti-coloured clothing was practically invisible at a certain distance. The idea is, of course, theoretically sound. No one shade can be equally indistinct against all backgrounds, since practically the aim will be to make the object the same colour as the scenery behind it. A dull grey, or khaki may be the best *average* tint, and on more or less desert plains the background is of one monotonous hue. But if a man dressed in khaki stands in bright sunshine in front of a dark shadow he will show out conspicuously, and so if he appears against a snow-drift he will be very plainly seen. A black and white chess board would appear at a distance of a dull grey, whether against a perfectly black or clear white background.

In speaking of uniforms for troops, one often hears the opinion expressed that one colour, say red, is more conspicuous than another. But it is forgotten that the ordinary British soldier is *not* dressed in red. He only has a red coat, and even this colouring is broken up by white belts, so that when seen from a distance he appears as a *pink* spot on a black one. So a line of men in khaki will often be easily discernible simply from the fact of their forming one band of colour, even though that colour very nearly approaches that of the background. If each man was dressed in a different shade of cloth the line of colour would be broken, and, therefore, not so conspicuous. Undoubtedly *the* most inconspicuous garb would be one in which the different portions were of different shades of colouring. And this lends itself to a smart dress. A Hussar's tunic of dark blue with a profusion of yellow braid is quite one of the most invisible combinations against any form of greenish-brown background.

A study of Nature emphasises the truth of this. Animals and birds are often of such colouring as to be practically invisible from afar, and this will generally be found to be not due to one special shade, but a combination often including black and white markings.

In naval circles, too, this subject of invisible covering has been attracting much attention. The great difficulty here has been that a tint most inconspicuous at sea in daylight shows up very light when under the rays of a search-light at night. Here, too, variegations would be of use. A ship painted chequer-wise in dark blue and grey would probably prove the least detectable by day and by night.

Attention must also be paid to the predominant light and shade. Many animals, like the antelope, are white underneath, just where, naturally, in strong sunlight, there would be a dark shadow. So a ship should have all parts usually in shadow painted white; the parts usually well illuminated, dulled. A gun should have its underneath part white so as to counteract the effect of shade.

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The Diesel Oil Engine.

WHAT promises to be one of the most important innovations in stationary and, perhaps, motor engines is the invention, recently imported from Germany, of Herr Diesel.

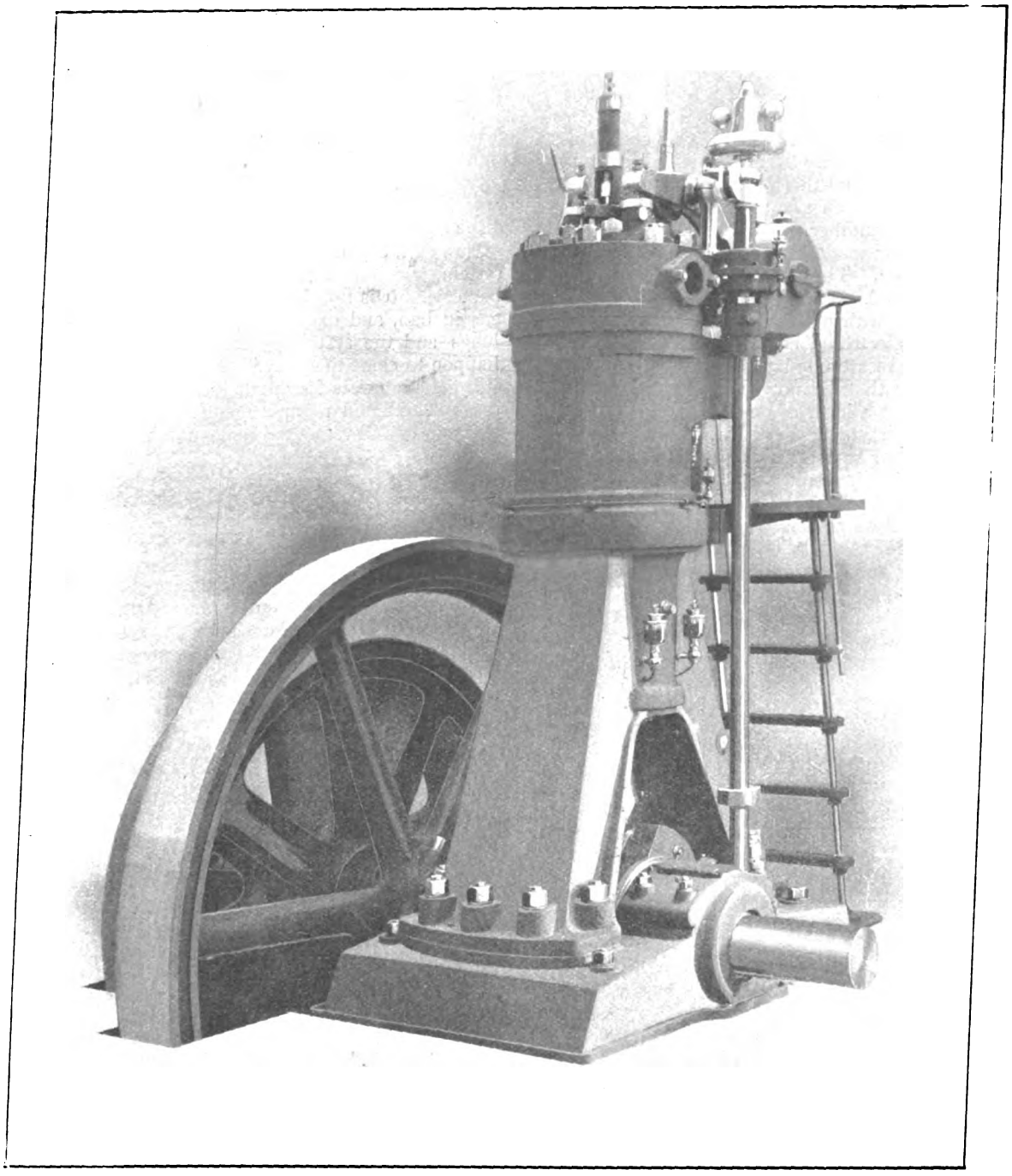
For several years past, at odd intervals, rumours have leaked out about a novel and very extraordinary engine having been devised by this inventor. But now we have the actual machine in England, and, moreover, it has been well tried and found to answer most satisfactorily. Some of the original rumours are now proved to have conveyed a wrong conception of the engine, or, as seems to be the case, the evolution of the invention has meandered through many paths, and in the present form some of the earlier ideas have been eradicated.

In order to make a description of the machine clearer to those unacquainted with its principles, it may be advisable to explain shortly wherein the novelty lies and how this engine differs from the ordinary oil motors. There are four principal points to note. First, the ignition of the oil-gas is automatically effected by heat without the application of flame, incandescent tube, or electric spark. Secondly, the fuel is injected only after the compression is complete, so that no premature explosion is possible. Thirdly, the fuel is injected gradually, so that no sudden explosion takes place. Fourthly, the mixed gases, at the moment of combustion, are under very great pressure.

In the ordinary oil engine the charge of petrol-vapour and air is drawn into the cylinder by the outward stroke, compressed to a pressure varying from 40 lbs. to 80 lbs. per square inch by the return stroke (actuated by the impetus of the fly-wheel), and then ignited by one of the means above referred to. High compression of the gaseous mixture gives a greater economy of fuel, and in the Diesel engine this is carried to a higher degree than in others. A small compressor air pump, driven by a side lever attached to the connecting rod, maintains the pressure in an air reservoir at about 500 lbs. to the square inch, and this compressed air is fed into the cylinder and further compressed by the return stroke. This high compression causes the air to become very hot, so much so as to raise it to a temperature in which the oil will spontaneously ignite. At this period the supply of oil is injected in a fine spray, with the result that it immediately burns and drives the piston forward.

It will be noticed how one condition brings about others. The greater compression of the fuel, desirable for economy, causes so great an augmentation of heat that it would have been impossible to use the ordinary mixture of air and gas without the liability of premature explosion. The addition of the fuel to the highly heated air causes the combustion of the former, and as the mixture at the desired moment cannot be instantaneous, further benefits accrue from its more gradual supply.

Another advantage of this engine is the ease of starting. All who have had any experience with oil-engines will appreciate the value of this. The compressed air stored in the reservoir is a power in itself sufficient to start the engine going, just the same as if steam was turned on, and is said to effect its work with the greatest ease and quietness. No preparation is necessary. When the engine is stopped the reservoir is charged with compressed air, and, thanks to securely-fitting valves, it remains in this state, even though weeks elapse before it is restarted.



80 H.P. Diesel Engine.

The next consideration is the actual form of the machine, the type usually made being that of a vertical stationary engine.

A large cylinder, open at its lower end, is placed vertically above the crank shaft. The latter, carrying a heavy fly-wheel, is rotated by the piston rod in the ordinary way. The cylinder is surrounded by an outer casing, the space between forming a water-jacket. In earlier models this was not applied, but the great heat developed in the engine necessitated its adoption. The cylinder for a 30-brake horse-power engine is about 12 inches diameter, and the stroke 18 inches. The piston is an open trunk of a length of $2\frac{1}{3}$ times its diameter. It is surrounded by a packing of 7 plain rings. The connecting rod is pivoted to the interior of the piston a little below its centre. The cylinder cover is hollow to allow of a water circulation for cooling,

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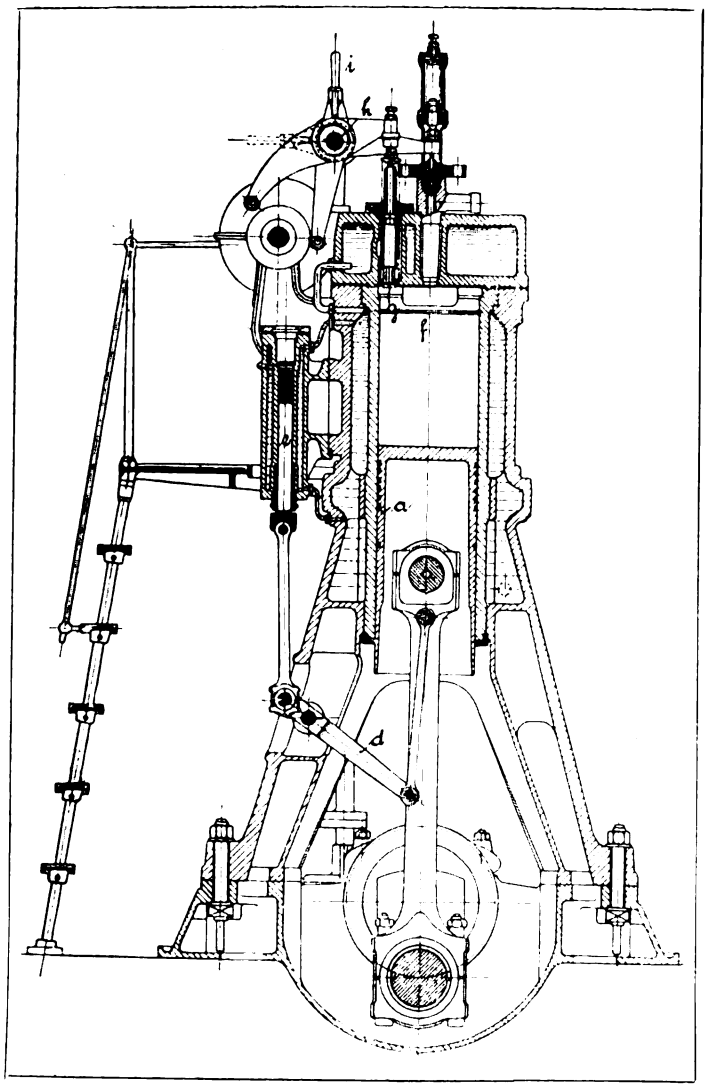
and in it are formed four valve boxes. The central plug valve admits the oil-fuel, and is opened by a lever operated by a cam. When opened, a number of small grooves are exposed, through which the oil is forced by a blast of compressed air, it having previously passed through some perforated discs, and is thus formed into a spray. The passage for the oil below the valve is 1-5th of an inch diameter, and from this it is driven through a small conical hole, with the larger opening downwards, and discharged in a conical jet into the cylinder full of compressed and heated air.



The quantity of oil blown into the cylinder is regulated by a ball governor, being supplied from a small feed pump. This forces the quantity of oil required for each stroke, about $\frac{1}{6}$ c. inch in a 30-h.p. engine, into the valve box.

The oil spray having been ignited as described, and having thereby driven the piston down, the exhaust gases are passed through a silencer and discharged into the air. These gases are invisible and without smell, and but a minute quantity of soot is ejected. No trace of deposit is to be found in the cylinder. The engine is said to run with great smoothness and practically no vibration.

The air pump, actuated by a lever, is placed on one side of the cylinder. The air is not drawn from the outside, but from the main cylinder during the compression stroke. This is an improved arrangement, forming a two-stage compressor, which, in addition to other advantages, allows of the air-pump being greatly reduced in size. It is now one-fourteenth the volume formerly considered necessary. This pump, which also has to be water-jacketed, delivers the air into two high-pressure air reservoirs, one being about $13\frac{1}{2}$ inches internal diameter by $5\frac{1}{2}$ feet long, the other about half those dimensions. In the smaller reservoir, a pressure is maintained of about 6 to 10 atmospheres above the maximum pressure in the cylinder. The larger reservoir is an overflow to the smaller one, a spring safety-valve connecting the two, and supplies the compressed air necessary for starting the engine. These vessels are made of Mannesman steel tube, and have to withstand a pressure of 40 to 60 atmospheres.

The water for the cooling-jackets is driven by a small belt-driven centrifugal pump to an overhead cooling tank, whence it flows through the pump jackets, then around the cylinder, and through the cylinder cover, back to the tank.

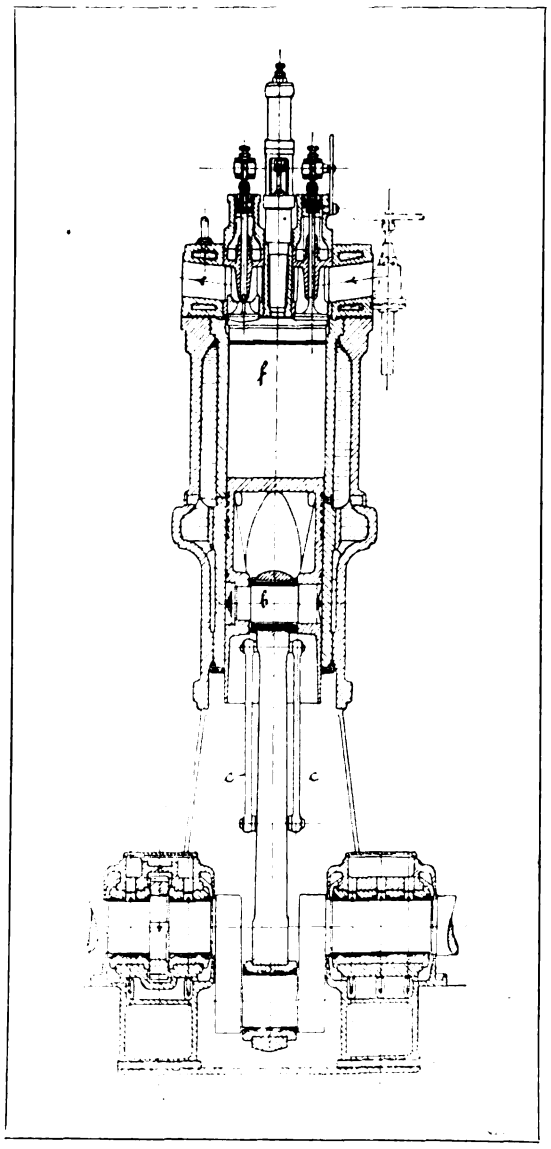
The valve for admitting the compressed air from the larger reservoir to the cylinder is opened by a lever, which is geared with a cam when it is desired to start the engine. After a few revolutions the lever is drawn back either by hand or, in some engines, automatically.

As regards the fuel used, it is on this point that the Diesel engine stands out as a distinct step in the progress of power engines.

The crudest of oils and petroleum refuse can be used as easily as refined oils, and the cost of working is consequently extraordinarily low. Based on London or other seaport conditions where the liquid fuel can be obtained at 35s. per ton, equal to 2d. a gallon, it is calculated that the cost is but little over £1 per brake-horse power per annum, at 54 hours per week working. That is, an engine of 100-horse power, running about 9 hours a day, will cost just over £100 a year for fuel.

With oil delivered on the spot at 45s. a ton, the actual cost works out at just one penny for 9 brake-horse power per hour.

It is true the prime cost of the engine is rather high, but where it may be double the cost of an electric motor, $1\frac{1}{4}$ times that of an ordinary oil engine, and about $1\frac{1}{2}$ times that of a gas engine, the



annual working expenses only come to about half that of the electric, less than half that of the oil, and not much more as regards the gas engine. So that, in a very few years, it would repay the greater outlay at the start.

The Composition of Sussex Natural Gas—is it Dangerous?

To the Editor of "THE ILLUSTRATED SCIENTIFIC NEWS."

DEAR SIR,—On perusing the article on "Natural Gas in Sussex," I noticed that, in regard to the analysis quoted, the proportion of oxygen is very high, compared with gas found in the United States. The highest percentage of oxygen in natural gas which I can find on an examination of a number of analyses is 2·1 per cent., while Heathfield gas is stated to have 18 per cent. As this proportion of oxygen has been quoted in the "Times" of September 10 and the "Engineer" of September 26, as well as your first issue, it must be assumed to be correct.

This being the case, I would point out that the gas *per se* constitutes an explosive mixture, which would be dangerous to life and property unless stored under such a pressure as to ensure the impossibility of flame flashing back, as it contains one-ninth of the total oxygen required for its perfect combustion.

On perusing the article in the "Times," I assumed that the statement that the proportion of oxygen was 18 per cent. was a clerical error, and that hydrogen should have been substituted. The origin of this proportion of oxygen must be a source of considerable speculation with those familiar with "natural gas."

A large gasholder full of the gas of the quality stated would be a source of extreme danger, as it would cause a terrible explosion in the event of the pressure being accidentally reduced to allow of the flame flashing back.

Yours faithfully,
HORACE ALLEN,
Civil Engineer and Metallurgical Chemist.

18, *Cristowe Road, Hurlingham, S.W.*,
October 3, 1902.

[*** In order to make sure that our account was not at fault, we have communicated with the engineer-in-charge, Mr. Inverness Watts, who writes to say that he believes the analysis to be correct.—ED.]

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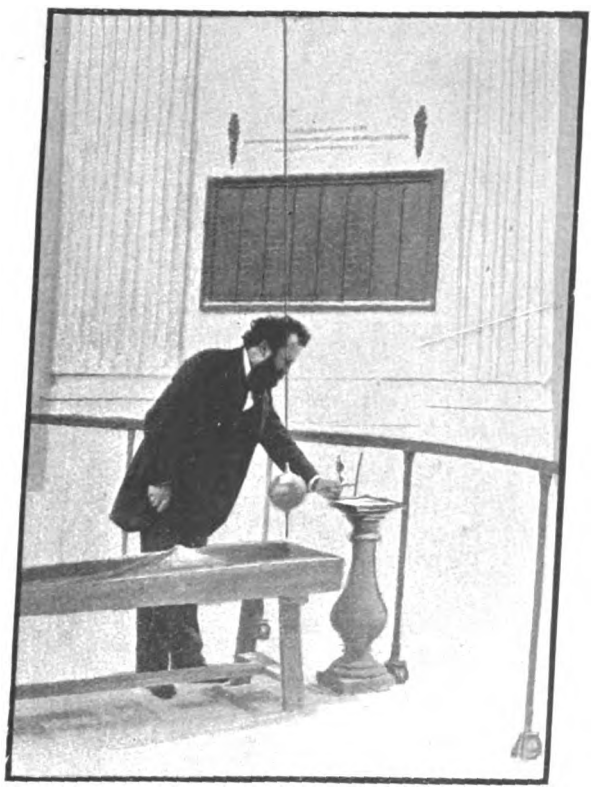
The Earth's Rotation.

AN EXPERIMENT WITH FOUCAULT'S PENDULUM.

AN interesting demonstration took place on October 22nd at the Pantheon in Paris, of a scientific experiment, giving ocular evidence of the rotation of the earth. To give a lucid explanation of the experiment, we may suppose, for instance, a bird-cage, within which a weight



Starting the Pendulum.

is suspended by a thread from the top. Start this weight swinging like a pendulum. It will naturally go on oscillating for some time in the same plane, that is to say, if started from the door of the cage it will swing to the other side and back to the door. But if, while it is swinging, the cage be gently turned round through, say a quarter of a circle, the plane of oscillation will not move with it. There is no reason why it should, except for the very slight torsional action of the thread. Therefore, the pendulum will now swing, not to the door, but to one side of it. Now suppose a huge cage were erected at the North Pole and a pendulum set swinging. It can easily be understood that as the earth rotates, different points will in succession be presented to the bob of the pendulum at each end of its swing. In fact, it would

The Pendulum in the Pantheon.

go on swinging in every direction round the circle until, after 24 hours, it would be in its original plane. At the Equator, on the other hand, a pendulum would remain oscillating in the same direction. So at intermediate latitudes, as at Paris, it changes in a modified manner easily calculable.

Over fifty years ago Foucault demonstrated this fact by means of a very long pendulum, but his experiments were interrupted by political troubles. Now, however, the Astronomical Society of France have re-opened the question and instituted these demonstrations.

The apparatus consists of a copper globe, weighing 66 lbs., suspended by a fine steel wire, 224 feet long, from the interior of the dome of the Pantheon. A pendulum of this length takes 16 seconds in its oscillation. From the lower end of the ball a needle projects, which, towards the end of each oscillation, marks a track in two small mounds of fine sand which are placed at the opposite extremities. In this way the exact bearing of the plane of oscillation can be seen, and the change in direction of each swing observed. In the centre of the ball a graduated circle is placed so that the angle of the swing can also be seen. In order to start the pendulum fairly and without twist, it is drawn to one side and retained there by a thread (as shown in the illustration opposite), and to further insure that it is not jerked in releasing, the thread is burnt through and the great pendulum starts off on its journey across the hall. On its return, after the sixteen seconds, the needle will be seen to make a fresh mark in the sand to the westward of that which it made on starting, and so it will continue, the deviation being at the rate of 11° per hour.

Some New Detectors for Wireless Telegraphy.

BY A. FREDERICK COLLINS.

(From the Scientific American).

INVENTION, like all evolutionary progress, travels in cycles. Wireless telegraphy is no exception to this rule, as a review of the results achieved will show, for yesterday the workers were madly striving for syntonic effects, while to-day electric wave detectors are engaging their attention, and to-morrow—only to-morrow will reveal the popular thought.

Of electric wave detectors there are two distinct types: (1) The familiar coherer in its many and varied forms; and (2) devices which depend upon the increase and decrease of magnetic permeability by the impinging electric waves setting up oscillating currents in the resonator system.

Mr. Marconi, Prof. Fessenden and others have taken up this latter type of detectors, since it offers not only a wide field for research, but it has been shown from theoretical considerations that in magnetic detectors as they are called, all the energy could be utilized, whereas in the coherer type only that portion of the energy could be utilized which is required to raise the potential to the critical point necessary to break down the maximum resistivity and the rest of the wave value is therefore lost.

To Prof. Elihu Thomson is given the credit of having first proposed the general principle embodied in electric wave detectors of the magnetic type. In Fig. 1*A*, the simplest arrangement is shown in outline representing an elevation, and in Fig. 1*B*, a plan of the magnetic detector is shown. In this form a silver ring, 1, is suspended

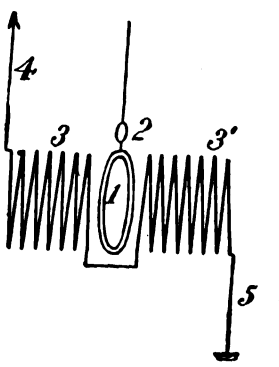


Fig. 1 A.

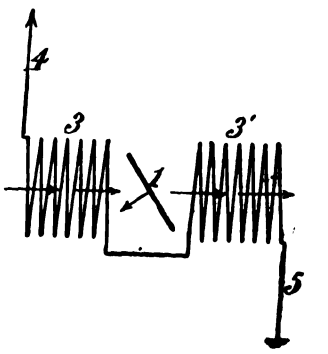


Fig. 1 B.

by a quartz fibre, and above the ring is attached a small mirror, 2, so that readings may be taken by means of a lamp and telescope just as in an ordinary reflecting galvanometer. The system is thus free to revolve between the parallel coils of wire, 3 3′, which are connected in series. The opposite and free terminals of 3 3′ of the coils are extended to or connected with the vertical wire, 4, and the ground wire, 5.

When the electric waves impinge on the antenna or vertical wire, 4, they set up high-frequency oscillatory currents, and these passing through the coils, 3 3′, join a rapidly-alternating field between them; these magnetic lines cut through the suspended ring, and currents are induced in it, and these have a tendency to turn at right angles to the coils creating the magnetic field; and in following out this law of repulsion the ring describes an arc equal to the opposing forces. This was the form of detector Prof. Fessenden employed in his tests prior to his work for the Government.

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To bring this detector into a more practicable form, so that a telephone receiver could be employed instead of the reading telescope, the instrument is somewhat differently designed and constructed from that shown in Fig. 1, though the principle is the same.

In this case the metal ring, 1, Fig. 2, rests upon three inverted wedges, 2 2′ and 3; 2 2′ are of metal, but 3 is of carbon. One terminal of a non-inductive resistance, 4, is connected to the inverted metal wedges, 2 2′, and the opposite terminal is connected in series to a telephone receiver, 5, and this in turn to the carbon wedge, 3. The electric wave system is formed by connecting the vertical wire to the metal wedges and the earthed wire to the carbon wedge. With these arrangements completed an alternating current from the dynamo, 6, is switched through the circuits; this produces a continuous vibration of the diaphragm of the telephone receiver, but when the electric waves impinge on the vertical wires the resistivity of the carbon wedge is varied and any change in it is registered by the telephone.

In Mr. Marconi's recent paper he describes a new form of detector which likewise depends upon a varying magnetic field produced by high-frequency oscillations transmitted from a distant point in the form of electric waves; but the electrical feature which places the stamp of originality on this new detector is the fact that it calls into action magnetic hysteresis.

In mechanical construction the Marconi detector is comparatively simple, consisting as it does of a layer of fine insulated copper wire, 1, Fig. 3, wound on a core. 2, made of thin iron wires; a second layer

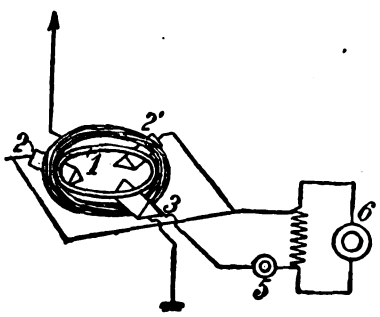

Fig. 2.

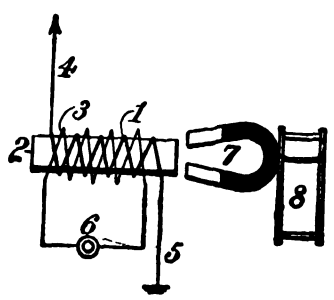

Fig. 3.

of fine insulated wire, 3, is wound over the first, forming a secondary coil. The ends of the inner coil are connected with the vertical wire, 4, and to the earth, 5. The terminals of the secondary coil are connected in series with a telephone receiver, 6, or other suitable receiving instrument. Up to this point it will be observed that there is but little difference in Marconi's device and those heretofore described, and all of them are based on the researches of Prof. Joseph Henry, who produced with a single spark from the prime conductor of a frictional machine an oscillatory current at a distance of 30 feet, sufficient to magnetize steel needles. But in applying the principle of hysteresis an entirely different detector results, and to understand this process the better, let it be known that the ascending and descending curves described in magnetic tests of iron do not coincide, and this being true it is self-evident some work is done, and this takes the form of heat; although practically it is so small as to be negligible. This process of hysteresis, it now appears, has the curious property of accentuating mightily every charge, however small, in oscillatory currents, set up in a resonator by the incoming electric waves.

Now in order that the bundle of fine iron wires forming the core of his detector may be constantly following a cycle of increased and diminished magnetization or continued hysteresis, Marconi causes a horseshoe magnet, 7, to revolve before the pole of the core by clockwork, 8. The magnet should be revolved very slowly—at the rate of one revolution every two seconds; the speed of course varying for the different qualities of iron employed; and in this way a slow and constant change with successive reversals of the magnetization results.

It might be supposed that the changes of polarity of the core would induce currents in the secondary coil of the detector which would be rendered audible by the slow motion of the magnet, and that if it were revolved at a high rate of speed better results would be obtained. This, however, is diametrically the opposite of what takes place in practice. The writer had occasion to make some experiments with an inductor type of alternator. With a telephone receiver in series with one of the windings, it was noted that when the rotor was turned by hand the reversals of the current were not noticeable and articulate speech exceedingly clear; but when the rotor was coupled to a gas engine and revolved rapidly a continuous hum in the receiver was apparent. These cases are identical.

The great advantage of the magnetic detector, as Mr. Marconi has pointed out, lay in its self-restorative qualities, and that its resistance is practically the same at any moment, whereas in a coherer before and after tapping there is always a wide and variable resistivity affecting the working of the registering instruments. It is claimed for this new detector that it is exceedingly sensitive and more reliable than the coherer, the latter being especially desirable in connection with syntonic wireless telegraphy.

While these points are advantageous, yet it would seem that the wide divergence between resistivity and its reciprocal, which is necessary in a detector to enable a relay to be operated, is in the magnetic detector lacking, and the limit of its usefulness will be confined to the telephone as a receiver; this may be of greater advantage than otherwise, since by means of the telephone wireless messages may be read more rapidly and at a greater distance than when the more cumbersome, costly and slower Morse register is used. Let this be as it may, experimental research is still going on with the type of detector that first made wireless telegraphy possible—the coherer.

Mr. Edouard Branly, of Paris, in his paper on "Variations of Conductivity," published in 1900, showed for the first time the effect of electric sparks on powdered metal inclosed in an ebonite tube; this tube he termed a *radio-conductor*, and was the first real coherer; and now he has given the results of his further researches in the form of a new coherer. To a metal disk, 1, are attached three metal rods, 2 2′ 2″, Fig. 4, with their points resting on a second disk of polished steel, 3. The points of the rods are oxidized. The success of the

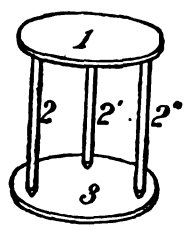

Fig. 4.

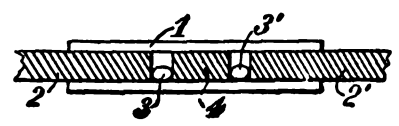

Fig. 5.

Branly coherer depends entirely on the oxidation of the metal points and the polish of the steel disk. The film of oxide may be preserved for a considerable length of time. Like Marconi, Branly has searched for a detector of stability greater than that offered by the ordinary coherer, in which the multiplicity of contacts gives rise to miniature trains of electric waves; in the Branly tripod form this is largely avoided. It requires a slight tapping to decohere it.

The details of another new coherer, designed by Signor Castelli and used in the Italian navy, and which is said to have been employed by Marconi in his recent trans-Atlantic tests, have been made public. The Castelli coherer consists of a tube, 1, Fig. 5, having its two terminal conductor plugs, 2 2′, oppositely disposed in the coherer tube and separated by two pockets, 3 3′, the interior plug being made of iron, 4. Into the pockets are inserted globules of mercury. The tube is self-restoring and in practice stands up well for regularity and rapidity.

REVIEWS OF BOOKS.

ELECTRICITY.

"*Galvanic Batteries*," by S. R. Bottone (Whittaker and Co.), 5s., is one of those books, only too rare, which contain the truth, the whole truth, and nothing but the truth, on the subject of their title. Herein we find a full, clear, and reliable account of the theory, construction, and use of all galvanic batteries. We have searched in vain for the conspicuous absentee, for every form of battery is described, and not only described, but all data, such as E.M.F., internal resistance, and adaptability to particular requirements is gone into. Primary batteries, secondary accumulators, and dry piles are in turn treated of, as well as gas batteries and "light" cells. It might have been expected that thermo-piles would also have been referred to, but the line must be drawn somewhere, and they are excluded. The book is written in a style so clear and free from abstruse phraseology that it may form an excellent introduction to the study of electricity. It is well up-to-date, giving a description, though necessarily short and perhaps incomplete, of Edison's new storage cell.

AERONAUTICS.

The Aeronautical Journal for October contains a report of the general meeting of the Aeronautical Society held on July 17th. Two papers were then read on the "Peace" balloon of Senhor Severo, by Dr. Carlos Sampaio and by Mr. E. S. Bruce, and a vote of condolence with the Brazilian nation was replied to at length by the Brazilian Minister. Other papers were read on "Balloon Ascents in Thunderstorms," "War Balloons in South Africa," and "The Cycala Flying Machine." Other articles include a biographical notice, with portrait, of the President of the Aeronautical Society, an account of the Balloon centenary at Bath, and the rules and regulations for the St. Louis Airship Competition. Many interesting notes, reviews of books, &c., follow.

ACOUSTICS.

"*Notes on the Construction of the Violin*," by W. B. Coventry, M.Inst.C.E. (Dulau). If, as the author says in the preface, "for the last two centuries no improvement whatever has been found possible in the construction of the violin," one may wonder what there is to write about. But this little bit of a book is full of scientific interest. There is a mystery in the excellence of the old violins. Their tone cannot be equalled, notwithstanding the most minute examination of the materials used and methods of construction, and the greatest exactions observed in imitating them. Evidently the secret lies in the wood used, and when age, soil, and even climate may have such an influence on the tree it becomes very difficult to select the most suitable material, or one exactly equivalent to that used by the old makers.

Among the forthcoming works to be published by Messrs. Macmillan and Co. are "*Studies in the Cartesian Philosophy*," by Mr. Norman Smith; a reprint of Lord Farrer's "*The State in its Relation to Trade*," and of Mr. Rowntree's volume on "*Poverty: A Study of Town Life*." Also a second edition of Mr. W. S. Taggart's treatise on "*Cotton Spinning*."

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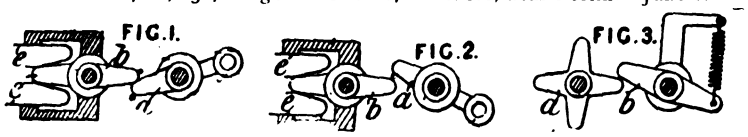
Recent Patents

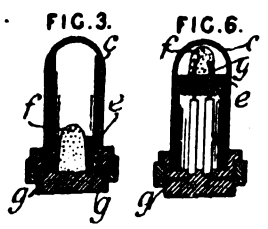
Selected from the IIId. Official Journal.

11,574. Explosion engines. HOCH, P., 6, Joseph-Strasse, Berlin, and LEHMBECK, T., 132, Ringbahn-Strasse, Halensee, near Berlin. June 6.



One terminal *a*, Fig. 1, wipes past another *b* retained in position by springs *c*, and produces a spark as shown in Fig. 2. Fig. 3 shows a modified form. The surfaces are kept clean by the rubbing contact. The lever *b* may be moved, while the lever *a* turns about its fulcrum against spring pressure.

11,597. Fire-alarms. SPANGENBERG, G., 14, Kleine Hochstrasse, Frankfort-on-Main, Germany. June 6.



Relates to an apparatus which will either close or open an electric circuit in case of fire, and thereby give an alarm. In the form shown in Fig. 3, *f* is a mass of fluid or fusible metal such as mercury, enclosed in a ring of tallow or the like *e*. When the tallow is melted by the heat of the fire, the mercury connects the two terminal wires *g* of the circuit. The device is re-set by inverting it, when the mercury flows to the bottom of the glass cover *c*, and the tallow solidifies above it. The form in which the circuit is broken by the fire is shown in Fig. 6. The fusible metal *f*, which connects the end of the wires *g*, is at the top of the case, supported on the surface of the tallow *e*. When the tallow melts, the metal *f* falls to the bottom, where the wires are insulated, and breaks the circuit.

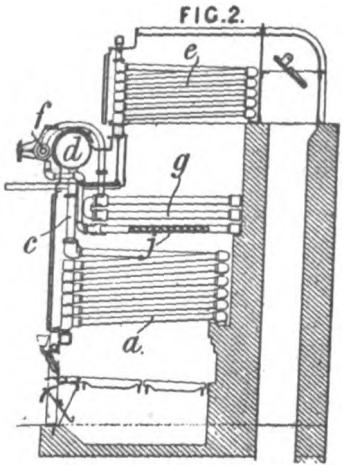
11,622. Photography. HADDOW, J. B., and TURNER, S. N., both of The European Blair Camera Co., Foot's Cray, Kent. June 6.

Roller slides.—Relates to a backing for films for roller slides. The backing of black paper usually employed acts upon the sensitive film. To obviate this, a backing of white paper is placed behind the black paper, and is thus interposed between the sensitive film and the black paper when the film is rolled up. The numbers for showing the section of the film being exposed, and marks to show where the sections are to be cut, are perforated in the white paper backing.

11,719. Photography. ABEL, C. D., Birkbeck Bank Chambers, Southampton Buildings, London.—(*Actiengesellschaft für Anilin Fabrikation: Berlin.*) June 7.

Sensitized plates and films.—Relates to processes for dyeing sensitive coatings to render the silver haloids sensitive to rays of different refrangibility. The plates or films (stained or unstained) are soaked successively in two or more dye-stuff solutions, the excess of dye-stuff being removed from the plate or film before it is passed from one solution into the next. Various examples of suitable solutions are given.

11,782. Water-tube boilers; superheaters, steam. DELAUNAY-BELLEVILLE, M. G., Saint Denis, Seine, France. June 8.

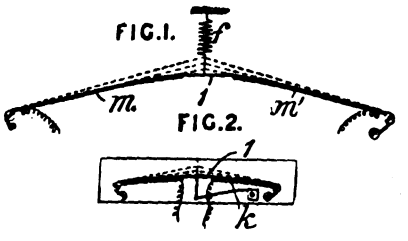


In a water-tube boiler of the Belleville type, a superheater *g* is placed in the path of the furnace gases between the water tubes *a* and the economizer or feedwater-heater *c*. The steam passes by tubes *c* to a steam-collecting and feedwater-purifying drum *d*, the passage from which to the superheater is controlled by a valve *f*. The superheater consists of a number of tubes connected at their ends by headers, those at the front having removable caps to facilitate cleaning. The tubes may contain helical metal strips *j* or other baffles.

12,593. Gas and Like Engines. REICHENBACH, F., 5, Teltowerstrasse, Berlin, S W. June 20.

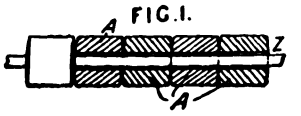
Igniting.—The combustible gas is ignited on entering the cylinder by contact with a charge of air or gases heated above the igniting point.

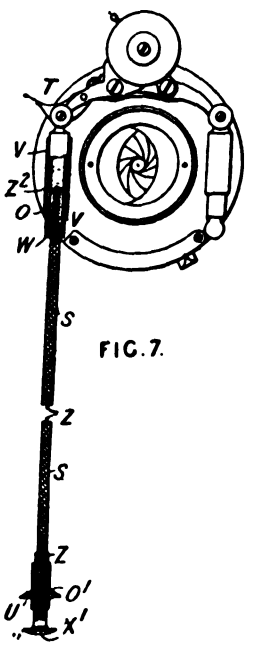
12,770. Regulating Electric Currents. IMRAY, O., Birkbeck Bank Chambers, Southampton Buildings, Chancery Lane, London.—(*Lindner, M.; 25, Himmelpfortgasse, Vienna*). June 22.



A wire is included in the circuit to be regulated, and is heated by the passage of the current. It regulates either by the resistance being increased with the increase of temperature, or by its expansion varying the length of resistance included in the circuit. Fig. 1 shows one arrangement. The conducting-wire 1 rests on fixed strips *m*, *m*¹ of non-conducting material, which serves to cool the parts in contact with it. When the wire expands, the spring *f* raises it at the middle, thus lifting it away from the strips *m*, *m*¹. In a modified arrangement, the strips are of conducting-material, and thus the effective length is varied. Fig. 2 shows a form in which the wire 1 rests on the bared upper part of a coiled wire *k*, *k*, but on expansion it is raised, leaving more or less of the coil in the circuit. In a modified arrangement, the wire 1 passes within a coil of wire, but acts in a similar manner.

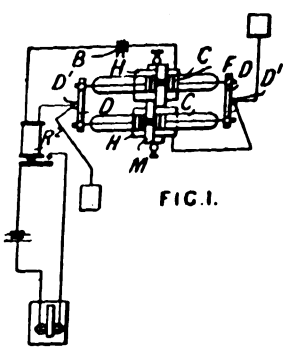
12,812. Photography. EDWARDS, A. H., 96, Lordship Road, Stoke Newington, London, N., June 24. *Patent not yet due for Sealing.*





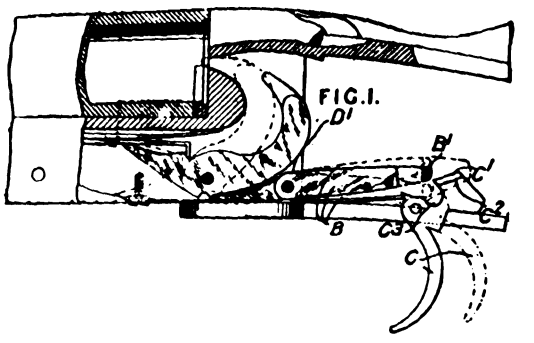
Shutters.—Relates to a mechanical device to replace the pneumatic ball and tube for actuating exposure shutters. A flexible cord is made up of two flexible parts, the outside part consisting of a series of short sleeves A, Fig. 1, with rounded ends, and the inside part of a flexible cord, Z. Various forms are given to the sleeves A. The movement is imparted to the mechanism of the shutter by the relative movement of A and Z. Fig. 7 shows the application of the device to a shutter. The cord Z is connected to the frame of the shutter by a cross-pin Z^2 and tube V, and the external sleeve to a tube W, which slides in V and is connected to the mechanism of the shutter at T. The relative movement of the cord and sleeve are produced by squeezing together the flange U and knob X^1, the parts being returned to their original position by the springs O, O^1, connected to the ends of the cord and sleeve. The sleeve may be enclosed in a braided cover S. Various devices are described for effecting the relative movement between the cord and the sleeve.

12,816. Wireless telegraphy. SHOEMAKER, H., 137, South 5th Street, Philadelphia, Pennsylvania, U.S.A. June 24. [Date applied for under Sec. 103 of PATENTS, &c. ACT, 1883, June 24.]



Relates to the coherer arrangements at the receiving-station. Two insulating coherer tubes C are mounted between arms D on posts D^1, and have the internal conducting-blocks F recessed to form a cavity between them. A double decohering magnet H has the end and central pole-pieces M^1 extended upwards and turned over the tubes so as to attract the filings, &c., upwards. The decohering magnet is in the local circuit with the coherers, relay R^2, and battery B.

13,213. Small-arms. TIGHE, M. A., Loosely House, Prince's Risborough, Buckinghamshire. June 28. *Patent not yet due for Sealing.*



Single-trigger double-barrelled guns.—The trigger C is provided with two shoulders C^1, C^2, which engage with the sears B. When the trigger is first pulled, the shoulder C^1 raises the pin B^1 on the right-hand sear and discharges that barrel, the sear being blocked at D^1, by contact with the action, before the trigger can be raised high enough to discharge the second barrel. Upon the release of the trigger, the pin B^1 drops opposite the recess C^3 of the trigger, so that upon the next pull, the shoulder C^2 raises the left-hand sear and discharges that barrel. The device is made selective, by providing a lower shoulder C^2 on each side of the shoulder C^1, and the trigger is moved laterally towards the barrel which is to be first discharged.

The Science of Illusion.

MYSTERY NO. 1.—THE SOLUTION OF "LEVITATION."

THIS effective trick, as has been said, can be performed in any drawing-room and with materials procurable in every village shop.

All that is required is a few reels of black cotton, a lot of lead piping (or other weights), and a few pieces of wood and cord.

It comes as a surprise to most people to find that common sewing cotton is strong enough for the purpose. Steel wire, however, has the objection of glittering in the light and also of making tell-tale noises if accidentally struck when in tension. The thread does neither of them, but the secret lies in the fact (which cannot clearly be shown in the illustration) of a great number of threads being used. Each is threaded through eyelets in a small wooden rod which is strapped to the performer's back, and through similar eyelets in a board suspended near the ceiling behind the curtain. Each thread ends in a weight, best made of a length of small lead tubing. This weight will vary with the thread used, being as heavy as it will allow without risk of breaking. This may be only, perhaps, 1 lb., in which case some 150 weighted

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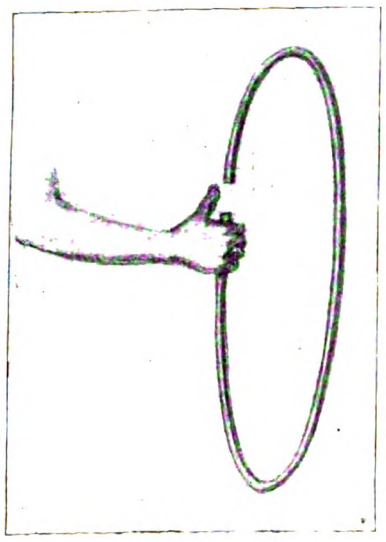

threads may be necessary; but they may be 1-10th-inch apart where near the body without being visible.

The new illustration will clearly explain the method of suspension. It will be seen that the wand can be waved freely above the head of the performer, under his feet or behind his back, without the sustaining threads being interfered with.

At the commencement of the performance all the weights are placed on a shelf or table, leaving the performer free to walk about, but if an attendant lifts them off, one by one, the performer will at length be lifted into mid-air, and will remain suspended until the attendant again lifts the weights on to the support.

The hoop referred to is made with a break in it (covered by the hand till required), which is held in such a way as to allow the threads to pass through.

MYSTERY NO. 2.—THE MAGIC WRITING.

The performer brings on to the stage a large picture frame surrounding a pure white canvas. This is placed upon an easel facing the audience. After some remarks and passes the performer, standing a couple of yards from the picture, points his wand at it and slowly traces in the air some figures. A black line suddenly appears on the canvas, growing in length and following the pointing of the wand, so that some figure or word is inscribed just as if the wand had been a brush or pen and had been touching the canvas. When the word or design is complete, a further word of command is given by the performer and the whole writing is seen to change from black into a deep red, and then into other colours. Finally, the performer turns round, and the design gradually fades away till nothing but the blank canvas remains. During the "manifestation" the performer throws his other hand about, making passes over the frame—and showing, by the absence of shadow, that no lantern light, etc., is thrown on the picture; and a board or other screen may be placed behind to show that no light is thrown from that side.

The explanation of this mystery will appear in our next number.

Prize Competition.

ONE of the principal objects of this journal being to encourage and foster the introduction and propagation of new ideas, the proprietors have decided to offer a series of money prizes to those who, in their opinion, send in the best and most practical solution of certain problems which will be set each month.

The designs must be sent in within a fortnight of the publication of the problem, *accompanied by the coupon* cut from this paper. Marks will then be allotted by the judges, and the competitor gaining the greatest amount of marks each month will be awarded the monthly prize of ONE GUINEA. But in order to encourage clever inventors, and not merely reward those who may happen to hit upon a happy idea, a GRAND PRIZE OF **ONE HUNDRED POUNDS** will be awarded at the end of the year (*i.e.* after 12 problems have been set) to that inventor who shall have gained the greatest aggregate of marks during that period, provided he shall have gained at least *30 per cent. of the full marks* in at least six of the competitions (whether he has gained a monthly prize or not).

In the event of an equality of votes or other exceptional circumstances, the proprietor will decide on the fairest method of distribution.

The following rules must be strictly adhered to, and solutions sent in not in compliance with them will be disqualified.

1. The solutions sent in must be concise, yet fully descriptive of the idea intended. To comply with this they must not exceed 300 words, and not more than two simple diagrams should accompany it.
2. Solutions will be published as considered desirable by the editor.
3. Competitors may obtain patent rights for their ideas, but they must run all risk of the publication in this paper interfering with the obtaining of such rights.
4. The number of marks awarded to each solution will be published every month. Competitors may send in their designs under a fancy name for publication, but their true names and address must be inserted on the coupon, which, in the event of their winning a prize, will be published.
5. The same person may send in two or more solutions so long as a separate coupon accompanies each.
6. Novelty of design is not a *sina qua non* (since this would be extremely difficult to prove), but only the person sending a description with the coupon is entitled to reward.
7. It would add to the value if a statement be added, to say if the design has been practically tried; but to corroborate this the inventor may be called upon to give a demonstration before receiving a prize.

Results of last month's competition.

"THE UTILIZATION OF TIDES."

(Full marks 100).

"HARDSTAFF" (55 marks) suggests the construction of two reservoirs on the beach extending into the sea, one of which, filling at high water, empties into the other, which empties at low water, there being then a continuous flow between the two, operating a wheel or turbine. *Marks are deducted for the great expense involved in such a plan.*

C. BURRAGE (55) submits a somewhat similar plan, but the reservoirs are inland and empty "into a sewer which has its outfall lower down the river." *Marks deducted for expense and doubtful means of disposing of used water.*

"CAP" (50) selects a creek or inlet, across which a dam is built, and siphons convey the water over it, moving turbines. *This presupposes suitable creek to exist.*

R. J. M. (40) would erect a circle of piles in the river bed between which floats a platform or pontoon on which the engine is placed, gearing on a rack on one of the piles.

P. L. PRESTON (25) and FRED (20) both suggest a raft or vessel on which machinery is rotated by the moving chains.

"BRADAWL," F.S.B., R. FENTON, and J. BLENKINSOP (5 each) send impracticable ideas.

"FOUNDRY," "EDGAR," E.M.F., "LUNADYNE," and "HILL" are disqualified for non-compliance with the rules (mostly sent in too late).

The first two named, having tied with 55 marks each, the monthly prize of one guinea must be divided between them. A P.O. for 10s. 6d. has therefore been forwarded to

"Hardstaff"—G. H. West, 7, Meyrick Street, Pembroke Dock, and to Cyril Burrage, St. Tydfil, Woodford Green.

The subject for this month, November, will be—

"AN AUTOGRAPHIC TELEGRAPH,"

that is to say, an improved method for transmitting a written message so that it shall be automatically recorded in legible writing at the receiving station.

COUPON.

To the Proprietor, ILLUSTRATED SCIENTIFIC NEWS.

I herewith forward my idea for a solution of the problem on "An Autographic Telegraph," according to the conditions published in your paper, and I agree to comply with those conditions.

Full Name.....

Address.....

.....

Fancy Name for publication.....

Date.....

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Astronomical Calendar.

NOVEMBER, 1902.

Month.	Day of Week.	SUN. Rises.	Sets.	Before Clock.	Right Ascension at Noon.	Apparent Declination (8th.) at Noon.	HIGH WATER. LONDON BRIDGE. Morn.	After.	MOON. Rises Morning.	Sets Afternoon.	Right Ascension at Noon.	Declination at Noon.	Age at Noon.	
		H. M.	H. M.	M. S.	H. M. S.	° ′ ″	H. M.	H. M.	H. M.	H. M.	H. M. S.	° ′ ″	D. H.	
1	S	6 54	4 33	16 18	14 23 3	14 13 30	2 14	2 31	7 54	5 21	15 17 33	15 50 22s	1 4	
2	☽	6 56	4 32	16 19	14 26 58	14 32 47	2 48	3 4	8 53	5 57	16 7 41	17 38 7	2 4	
3	M	6 58	4 30	16 20	14 30 54	14 51 50	3 21	3 38	9 49	6 40	16 57 57	18 37 22	3 4	
4	Tu	7 0	4 28	16 20	14 34 51	15 10 38	3 56	4 13	10 38	7 29	17 48 4	18 46 31	4 4	
5	W	7 1	4 26	16 19	14 38 48	15 29 12	4 29	4 45	11 21	8 22	18 37 48	18 6 11	5 4	
6	Th	7 3	4 25	16 18	14 42 46	15 47 30	5 2	5 20	aft.	9 19	19 26 57	16 38 43	6 4	
7	F	7 4	4 23	16 15	14 46 45	16 5 32	5 41	6 3	0 31	10 20	20 15 30	14 27 46	7 4	
8	S	7 6	4 21	16 12	14 50 45	16 23 18	6 28	6 54	1 0	11 24	21 3 38	11 37 55	8 4	☾
9	☽	7 8	4 19	16 8	14 54 46	16 40 47	7 24	7 56	1 27	mrn.	21 51 40	8 14 31	9 4	
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11	Tu	7 11	4 16	15 57	15 2 50	17 14 55	9 50	10 25	2 15	1 38	23 29 34	0 13 56s	11 4	
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16	☽	7 20	4 9	15 15	15 23 14	18 34 55	1 44	2* 5	5 11	7 55	4 11 20	17 45 5	16 4	
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18	Tu	7 23	4 6	14 53	15 31 30	19 4 40	3*13	3*36	7 14	10 6	6 17 43	18 30 40	18 4	
19	W	7 25	4 5	14 40	15 35 39	19 19 2	4* 1	4*25	8 25	10 55	7 19 22	16 58 0	19 4	
20	Th	7 27	4 4	14 27	15 39 49	19 33 3	4 50	5 14	9 41	11 36	8 18 28	14 21 33	20 4	
21	F	7 28	4 3	14 13	15 43 59	19 46 43	5 41	6 8	10 54	aft.	9 14 37	10 57 28	21 4	
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Notes and Comments.

M. Santos-Dumont is reported to have said "If any person in England will undertake to promise £10,000 to be paid to me if I succeed, I am prepared to sail in my new airship from the Bois de Boulogne to Hyde Park." Yes, but is that a fair bet? Who will give the £10,000 without any chance of return? If the intrepid aeronaut is prepared to pay, on his part, say, £1,000 if he fails, he will doubtless have many "takers."

* * *

Marconi's powerful apparatus for creating ethereal waves, by means of which he is able to talk across Europe, is now being cried out against by the numerous operators of more humble installations. They compare him to a loud-voiced man whose shouting drowns all attempts at quiet conversation. Not only the immediate neighbourhood but the whole of Great Britain comes under his influence. Still, the opening of wireless telegraphic connection with America would be so grand an accomplishment that lesser issues must suffer, for the present, and doubtless reflectors or other means will eventually be introduced to confine the waves to their legitimate channel.

* * *

Very shortly legislators will have to be considering the imposition of a tax on horses. It is bound to come sooner or later, and the sooner it is imposed the better for health, comfort, and encouragement of industry. Horses spoil the roads and kick up dust; they make them indecently filthy; they are a source of danger, especially if not very carefully looked after; and, especially on the greasy streets of London, continually give an exhibition of suffering of the most agonizing kind, which ought to make humanitarians cry loudly for the "emancipation" of the cart horse.

* * *

The so-called Boer Generals—farmers and others who acted as leaders in the recent war—are sometimes now spoken of as great strategists. But let it be remembered that during the earlier stages the Boer forces mostly sat in strong defensive positions, and, luckily for us, missed every opportunity of counter attack, and that latterly their military science simply consisted of evading our forces and watching their opportunities. Out of several hundred bodies of our troops, wandering about the country for over two years, only about a dozen can be said to have been worsted. And meanwhile, these generals lost all their guns, most of their wagons, and more than half of their men. Does that sound like good strategy?

Sound-producing Writing.

A New Method of Reading for the Blind.

So many strange inventions have cropped up latterly that we hardly express surprise when we hear of devices of seeing by electricity or communication without wires; but it does sound rather remarkable when we hear that M. V. de Turine has invented a method of making printed books such that they can give forth sound and so communicate their contents to the blind. Yet the invention is not really so remarkable as may at first be thought. The writing consists of a number of small squares arranged on a principle similar to the Morse alphabet. The paper is transparent, and the printing consists of a black background with the squares left blank. To "read," the paper is placed on a glass screen in front of a light and an opaque piece of cardboard with an aperture corresponding to the transparent squares is passed before it. When this aperture passes one of the squares light is transmitted through on to a photophonic apparatus and a sound is produced. This photophonic apparatus may be of various forms, but generally consists of a plate of selenium through which an electric current is passed, so arranged that when the selinium is illuminated, the current causes a slight noise to be made. In this way the blind person hearing the varying sounds with longer or shorter intervals of silence, may read just as a telegraphist reads by the click of his instrument.

Judging by the written description, M. de Turine's apparatus appears to be somewhat complicated both in construction and in method of using.

Though books can, perhaps, be printed in this way very cheaply, the expense and complication of the reading apparatus would almost seem likely to debar its practical adoption, considering that if perforations in the paper were used, though more costly to produce, the same result could be attained by the simplest means.

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THE ILLUSTRATED

Scientific News.

A Monthly Journal devoted to Popular Science.

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The Invisible Universe.

BY SIR ROBERT BALL, LL.D., F.R.S.

ON any clear night some few thousand stars will be visible to the eye without any further optical aid. With the assistance of a small telescope an enormous increase in the number of the stars will be at once perceptible, and with every increase in the power of the telescope the number of apparent stars in the heavens waxes greater and greater. No one has ever attempted to enumerate the precise number of stars that might be counted in a celestial survey made with great telescopes under suitable conditions. Estimates have, however, been formed, based on careful counting of the number of stars to be seen in small selected areas, and it has thus been possible to obtain some notion of the total number of stars that lie within the range of our great instruments. As may naturally be expected, the estimates vary a good deal, but the lowest would not be much less than a hundred millions. There are other estimates which place the number of visible stars at two hundred millions, or at numbers even higher still.

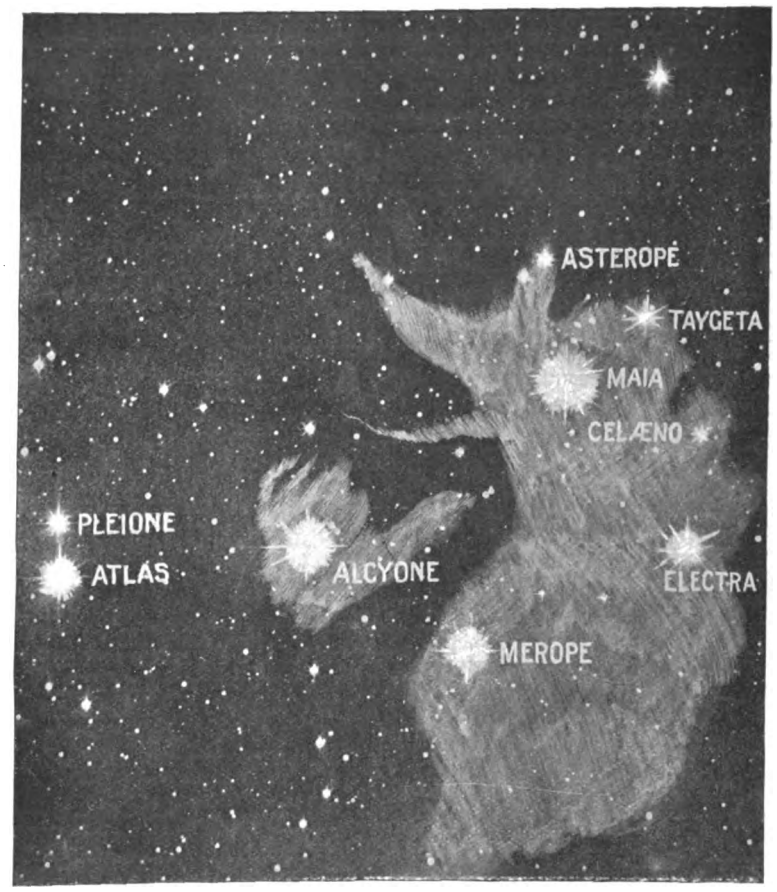
The Proof of the Invisible.

As every increase in the power of the telescope brings more and more stars into view, and as the number of new stars increases in a ratio even more rapid than that of the increase of the power of the telescope, it seems quite certain that there must be innumerable stars which up to the present have been quite unperceived. If we further bear in mind that the region of space submitted to the examination of our telescopes can be no more than an inconsiderable point in comparison to the extent of infinite space, it is obvious that the unseen stars must be enormously greater, probably untold millions of times more numerous than the stars which come within our ken.

But there is another line of thought which will also conduct us to the conclusion that the Universe we see must be as nothing in comparison to the Universe as it actually exists, but of which by far the greater part is totally invisible. We must remember that what we call a star is perceptible only because it is a self-luminous object. It is a body heated to a temperature sufficiently high to cause it to glow with vivid incandescence. A body like our own globe which has no light of its own, or like the Moon, or like the planet Jupiter, if placed at the same distance from us as one of the ordinary stars, would be totally invisible to dwellers on the Earth. It could never under such circumstances shine by mere reflected light. The sunlight or the starlight that might fall upon it would be wholly insufficient to give the surface of the body a luminosity which would render it visible from such distances as those from which we view it. Hence we are led to the remark that the objects we see in the heavens can be no more than the exceptionally bright points of the Universe. We must necessarily remain in ignorance of the parts which are not so bright. Nor can we doubt there are such parts.

How this may be illustrated.

Let us imagine some being who came from some other world with the object of viewing this Earth. Let us suppose that he arrived in the neighbourhood of the Earth at midnight and, while still far aloft, were to look down on London, how little would he see of the mighty city sleeping beneath him! He would, no doubt, be able to perceive many of the lights by which the city is illumined, he might notice perhaps by the arrangements of the lights that among the forests of houses some special features distinguished the areas of the parks or the breadth of the river. The innumerable lights of London he



The Pleiades: From a photograph lent by the Royal Astronomical Society.

might indeed discover, but of the city itself he could see nothing. The great buildings and monuments, the wondrous life and activity that make up this great city would be wholly shrouded in the darkness; he would see nothing of them. Now suppose this observer could obtain no further knowledge of London than this distant midnight glimpse, would not his conception of the city be ludicrously inadequate and incomplete? He would indeed have seen the lights, but of what the lights illumine he would have seen nothing. In like manner, when we look up at the heavens the only view of the Universe which is vouchsafed in truth to us is as ineffectual as that midnight view of London which I have just described. We see the lights of the Universe, but those greatly more numerous objects which are not themselves luminous are completely hidden from our view.

Our knowledge of the Universe becomes enormously augmented according as we acquire the means of learning the existence of those objects which are not luminous enough for us to see. To be self-luminous means in general to be hot, and for an object to be hot is,

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from the nature of the case, a temporary condition. It may remain hot, like the Sun, for untold myriads of years, but even in this case such a condition cannot be of infinite duration. The Sun has not always been hot; the Sun will not ever remain hot. If a celestial globe be so hot as to be capable of light and heat, we must conclude that it has been in some way subjected to exceptional conditions, the effect of which has not yet passed away. And for each body that is glowing under exceptional circumstances, there are doubtless a vastly greater number of bodies which are not at the moment hot enough to glow into visibility. If we will but look at the probabilities of the case, it seems obvious that those objects which are not at present in that highly-heated condition which would enable them to radiate light must be hundreds or thousands or millions of times more numerous than those bodies which happen to possess a sun-like temperature. The inevitable inference is that, inasmuch as we can see only the intensely-heated bodies, we probably see only a very minute fraction, probably much less than a millionth part, of the actual Universe. In this statement it will be noticed that we are referring to those objects alone which, had they been in a sunlike condition, are quite near enough to have been within the reach of our telescopes.

The Magic of the Photographic Plate.

But we are not left merely to surmise in our knowledge of the invisible contents of the heavens. There are, of course, certain differences between the perceptive powers of different eyes: some persons will see easily what others can only see with difficulty, or cannot see at all. But from the astronomical point of view the photographic plate has a perception of faint objects far transcending in delicacy the power of perception of any visual organ. Among the discoveries which photography has enabled us to make in the heavens, the most startling, I think, are those in which the photographic plate discloses objects whose luminosity is so feeble that we have never been able to see them. I do not mean merely objects which are too faint to be seen by the unaided eye. I mean objects which are too faint to be seen with even the most powerful telescope.

Let me give an illustration. I take for this purpose the case of that beautiful group of stars which are known to us as the Pleiades. From the earliest ages this exquisite cluster has attracted the attention of those who love to study the heavens. Ever since the days of telescopic astronomy commenced, the group in the Pleiades has been examined night after night by the most skilful and painstaking observers. But it is no disrespect to the vigilance and skill of all these telescopic astronomers to say that there was a most important feature in the Pleiades which entirely escaped their notice. When a highly sensitive photographic plate, suitably arranged in a telescope, was directed to the cluster, and when that plate received an exposure of an hour or two, all extraneous light being carefully excluded, then a remarkable discovery was made. The numerous bright stars in the Pleiades were, of course, seen on the photograph just as they are seen with the eye at the telescope. But besides showing these objects which were within the reach of the astronomer's view, the photographic plate also revealed certain features beyond the power of any eye. It showed unmistakably that the cluster of stellar points forming the Pleiades were enveloped with a wondrous fire-cloud, or nebula, as astronomers generally term it. At first, when this nebula as a sort of haziness appeared on the plates, it was natural to conclude that it must have arisen from some accidental defect in the plate, or from some irregularity in the development, or from some stray light that had found admission. Some explanation of this kind would certainly seem to receive confirmation when on further careful scrutiny of the Pleiades, the most experienced astronomer, using even the most powerful telescope, totally failed to see any trace of the astonishing nebula. But when photograph after photograph was taken of the same object, when the plates were varied, when reflecting telescopes as well as refractors were used in taking the pictures, and when the same result appeared every time, it was no longer possible to doubt its existence. The mighty nebula in the Pleiades has now to be reckoned as a well-established feature in the heavens, even although no one has ever seen it. It belongs emphatically to the invisible Universe.

The Strange Story of Algol.

In some ways also we have been able to confirm by direct evidence the existence of dark but mighty stars, though, as I have already pointed out, it seems to be impossible from the nature of the case ever to bring them within the range of actual vision. But though the dark star is not to be seen, yet its presence can be indirectly manifested in certain cases. The necessary conditions under which alone it is possible to do this are extremely rare, a fact which perhaps makes such cases all the more interesting whenever they do occur. I now refer particularly to the far-famed star named Algol, which lies in the constellation of Perseus. It has been known for centuries that Algol changes its brightness in a somewhat mysterious manner. Under ordinary circumstances, it can be seen nightly as a star of the second magnitude. But presently it undergoes a remarkable change. After two or three days of apparent constancy its light begins to decline. From being a star of the second magnitude, Algol declines until it becomes a star of no more than the fourth magnitude. Three or four hours are occupied in this transformation. When the brightness has sunk to the lowest point, the star's apparent magnitude remains fixed for twenty minutes, after which it again begins to brighten up so that in a little more than three hours, that is to say, about seven hours after the cycle of change has commenced, Algol is found restored to its original magnitude. At this brightness it remains for another two or three days, when the same cycle of changes again recurs.

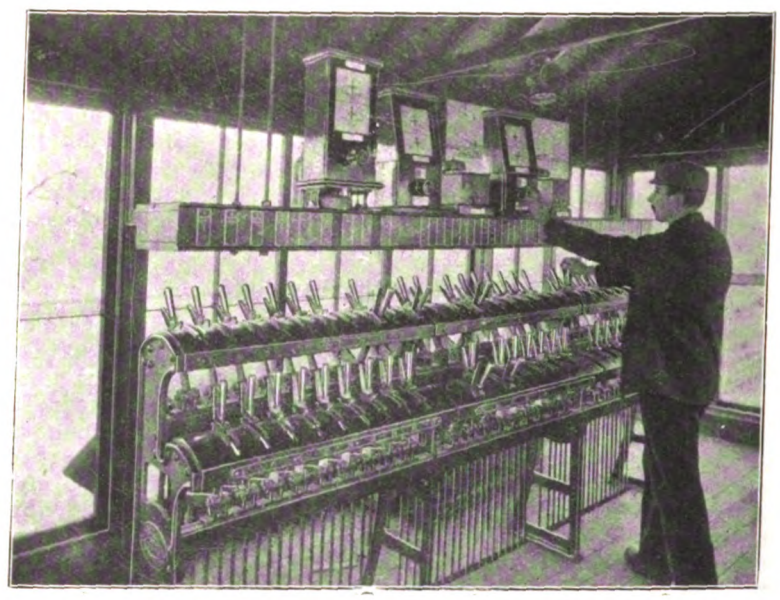
It has been one of the triumphs of modern discovery to have provided an explanation of the phenomena of Algol. It now appears that the bright star is a sun-like body, and that round this sun-like body a dark star revolves. It so happens that the plane in which this dark star moves comes very close to the observer's eye, and hence, in the course of each revolution, the dark object comes between the eye and Algol and intercepts a portion of its light. Even under these circumstances we cannot be strictly said to see the dark star. All we do see is the diminution in light of the bright star which has been produced by the interposition of the dark one. There are other circumstances which show that in the case of Algol we have demonstrative evidence of the existence of a body totally dark, yet comparable in magnitude and weight with our own Sun. It should also be remembered by what a fortunate chance we have been able to learn the existence of the dark body. This invisible star might have been very close to Algol. It might have been revolving around Algol. All this might have happened without our ever having dreamed of its existence. For us to discover this dark star it was further necessary that the plane in which it moves should pass through the eye of the observer. The fact that a body is found to fulfil these conditions suggests that there are in all probability a very much larger number of bodies which do not fulfil them and consequently remain invisible. Thus Algol provides another illustration of the astonishing proposition that the visible stars and other objects in the heavens, innumerable though they doubtless are, must nevertheless be immensely transcended in number and mass by those objects which form the invisible Universe.

ROBERT BALL.

Electric Railway Signals.

The "Crewe" System.

FROM the very earliest days of railways down to the present time one of the greatest problems which has been attracting the attention of railway engineers has been that of the efficient signalling of trains. Although the "absolute block" system of interlocked points and signals is, at all events so far as mechanical devices are concerned, almost perfect, the human agency is unfortunately not infallible, and the severe physical exertion entailed by the working of the heavy levers is bound to be responsible for a large proportion of the accidents which annually occur. Few people have any adequate idea of the strength required to pull an ordinary signal lever, with, perhaps,



Electric Signal Cabin at Crewe of Sixty Levers.
From a photograph lent by the Railway Signalling Company, Liverpool and Westminster.

a couple of hundreds of yards of steel wire attached to it; and it occasionally happens, particularly in frosty weather, that the wire snaps, with the result, of course, that the operator is sent flying on to his back!

The advantages of a power system of working points and signals are so obvious, and so generally recognised, that it is not necessary to refer to them here; but it must be said that a signalman who is mainly occupied with the moving of some thirty or forty cumbrous levers, cannot be expected to pay that attention which he should to the movements of the trains, and the positions of the points and

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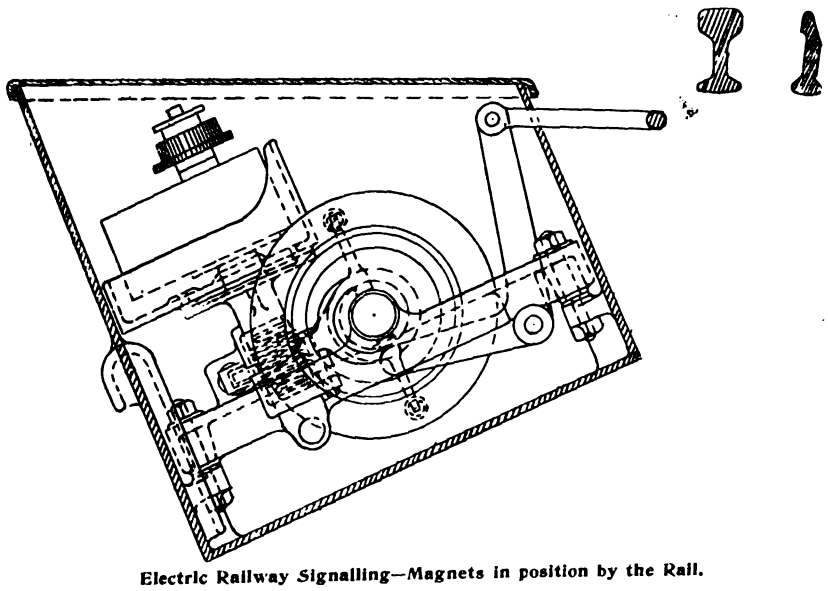
signals for which he is responsible, while, again, the work in a large cabin involves the employment of three or four men. In this case a divided responsibility exists—a frequent cause of mistakes, so that if any further argument in favour of power working is needed, it is that one man can do the work of three.

An electrical power signalling system, which bids fair to be soon adopted to a large extent on English railways, is that known as the "Crewe System," which has been invented and perfected jointly by Mr. F. D. Webb, the locomotive superintendent, Mr. A. M. Thompson, the signalling superintendent of the L. & N.W. Railway, and Mr. I. Timmis, the inventor of the "long-pole" magnet. Hitherto the power systems experimented with have been either hydraulic, pneumatic, or pneumatic with electrically-controlled valves and all of these systems have their disadvantages—that is to say, they have been found undesirable for practical working either on account of their expense or complicated mechanism, or it has been found—and this applies particularly to the hydraulic and pneumatic systems—that the actuating forces have been affected to a greater or less extent by the fluctuations of the weather. By the application of electrical power, however, these disadvantages are practically eliminated. The installation at Crewe, which has been in operation for three years, consists of motors for working the points, and electro-magnets for working the disc and semaphore signals, the current being derived direct from the lighting mains at 110 volts. Except in the largest cabins where there are frames of 200 levers, twenty-five amperes at 100 volts is said to be the maximum demand. It will thus be seen that the amount of power required is extremely small. The motors for moving the points work with a cam and worm, the mechanical parts working



Electric Railway Signalling—Magnets in position by the Rail.

in a bath of oil. The signal cannot be lowered, or electrical connection made with the solenoid for working the signal, until the point is locked in position. When it is desired to move a point, the handle or switch in the frame is pulled about half-way over and stopped by a detector. This motion makes a connection with the motor through a carbon break switch. The motor rotates and carries the point over. Until this has actually been done the return current is not sent back to the cabin through the detector, and the operator is, therefore, unable to complete the full throw of his handle and lower the signal. When, however, the point is locked, electrical connection is made through a solenoid which releases the lever and the signal can be placed at safety. It will be seen that a minimum of labour is entailed in working the levers, and, as the boxes which contain the motors and detectors are sunk to the level of the line, they form no obstruction or danger to shunters. Another important advantage is that, with electricity as the motive power, a greater distance can be safely and rapidly worked over.

A New Telephone Transmitter.

A NEW YORK inventor has been testing a novel form of telephone transmitter. This consists of a fixed high resistance conductor, such as a rod of carbon, which is supported from the frame carrying the vibrating diaphragm, without, however, touching the latter, and is permanently connected in the primary or microphone circuit of the induction coil. This type of transmitter is said to be extremely sensitive, while at the same time it is proof against that common defect of many ordinary transmitters when subjected to sudden noises or vibrations, viz., the complete rupture of the primary circuit. Its only defect would appear to lie in the gradual oxidation of the metal conductor, unless the latter be of platinum, and also the fact that it can only be used in a vertical or semi-vertical position.

Thermit.

A SIMPLE METHOD OF PRODUCING INTENSE HEAT.

THAT the very ancient peoples inhabiting parts of Scotland, as well as other places, had some means of producing intense heat at a given spot, such as is quite unknown to modern science, seems undoubted. The marvellous vitrified walls which have been found in several different localities cannot be otherwise accounted for than by presuming that their builders had some means of readily applying a very great heat to the wall after it was built up.

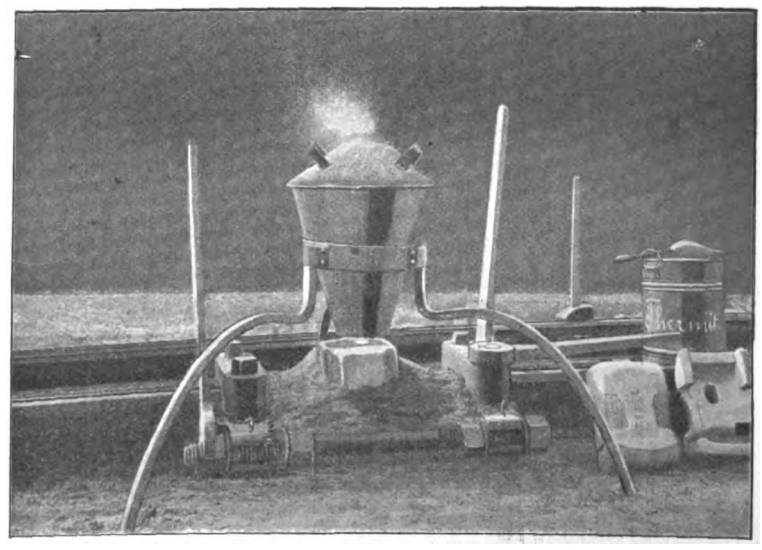
It is only quite recently that a substance has been concocted which, burning at a very high temperature, is capable of being practically applied locally. This is "Thermit," the invention of Dr. Hans Goldschmidt, and though it has been for some little time much used in the trade in Germany, and to some extent in England, yet is very little known to the outside public.

To begin with, it may be asked, "What is Thermit?" To look at, it is a dark-coloured metallic coarse-grained powder, not unlike gunpowder in appearance. It is a composition of aluminium and iron oxide, the separate grains of which are easily detectable on close examination. It is uninflammable by ordinary means, and may even be thrown on a fire without burning, but if a pinch of a special ignition powder be placed upon it, and this be ignited by an ordinary fusee, the whole will burn up, giving forth a brilliant flame and emitting a very great heat. So great is the temperature of the burning mass that if a small heap of the powder be placed on a sheet of iron, perhaps a quarter of an inch thick, and ignited, in a few seconds the iron will be melted, and a hole burnt right through it! The temperature attained is said to be no less than 3,000° Centrigrade (5,400° Fahrenheit). To make this more easily perceptible to the lay mind it may be remarked that "dull red" heat is about 700° C., "orange" 1,200°, and "bright white" 1,400°, while the melting point of iron is 1,530°.

Not only does this compound give off great heat, but, in doing so, two valuable products are formed—a pure molten iron, and a hard slag. The chemical action may be expressed by the formula:

$$2\,Al + Fe_2O_2 = Al_2O_3 + 2Fe.$$

The iron obtained is, therefore, quite pure and free from carbon, so that it is not like ordinary cast iron, but has the characteristics of a very mild steel, being exceedingly tough and tenacious. It will be readily comprehended that this exceedingly hot molten iron may be usefully employed for many purposes, such, for instance, as welding together iron pipes or steel rails. In practice, it is usual to employ a special crucible, into which the Thermit is placed. After a few seconds the reaction is complete and the crucible will contain, at the bottom, the molten iron, covered with a layer of three times its volume, but an equal weight, of molten slag. The crucible may be emptied either by pouring from the top, so that the slag flows out



Welding a Tram Rail by Thermit.
From a photograph lent by Mr. Masterman.

first, or by drawing off the molten iron from the bottom. According to the requirements of the case, one or the other of these methods may be employed. Thus, in welding iron pipes, or other hollow objects, it is desirable first to allow some of the slag to cover the join. This, cooling rapidly, forms a layer on the object it touches, which is thus protected from contact with the molten iron which follows, otherwise it would be liable to be melted through. The utility of the process is thus apparent. To weld together two steel or iron pipes all that is necessary is to clamp them pressed close together end to end, place a mould around the joint, and pour in the contents of the crucible. The ends of the pipes will thus be heated

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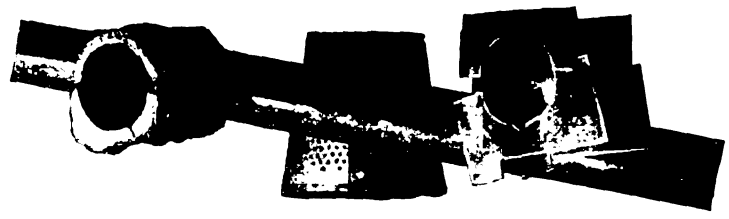
to the welding point, when the clamps are tightened to obtain the necessary welding pressure. After three or four minutes the surrounding mass may be hammered off, and the joint is complete. The weld once made requires no repairs, and stands as high a pressure as the pipe itself. Angle irons and bars of other sections can be equally well joined in this way, the result being a clean butt weld practically invisible except to the closest scrutiny. The second method, that of drawing off the molten iron, has the merit that, flowing out at such a high temperature, it melts the surface of the metal with which it comes in contact, and amalgamates with it, so as to form a homogeneous mass. This process has been largely



Moulds for Welding Pipe by Thermit.

used for welding tram rails and other like purposes. The iron thus formed around the joint can, of course, be of any desired thickness, and in the case of rails, may take the place of sole-plates and fish-plates, with the difference that it is securely welded on. One kilometre of tramway lines in Dresden was thus welded, and has stood well for over a year, the breakages during that time being only about 1 per cent. of the actual welds made. The welding was found in practice not to take longer than the fitting of an ordinary fish-plate.

In many cases no crucible even is required. A mould may be formed around any point, such, for instance, as where a large roller boss is broken off, and some molten iron poured in. Then, by adding Thermit and more iron, a complete new boss may be cast.

To render both molten steel and cast-iron more fluid, as will often be desirable in various manufactures, an addition of 1 to 6 per cent. of Thermit, according to requirement, will attain the desired result.

When large quantities of molten metals are to be dealt with, a certain proportion of bits of iron, such as punchings, can be mixed with the Thermit, and will be melted with it. In large quantities about 15 per cent. of iron may be added.

Besides the melting of iron and steel, this means of producing great heat will have many other applications, such, for instance, that of producing certain metals for alloys in a very pure state and free from carbon. Results can thus be attained which have not, so far, been possible even with an electric furnace. Chromium and manganese are, perhaps, the most important products obtained.

The production of corundum is another branch of the process. It is known as "Corubin," and is a peculiarly hard and sharp form of emery, the applications of which are numerous and well known.

As regards the cost of this process, much will, of course, depend upon the nature of the work. As an instance, however, the welding of a wrought-iron pipe, 2 inches diameter, will require about 3 lbs. of Thermit, which costs from 10d. to 1s. per lb. Larger operations will require a larger amount in proportion, thus, a 6-inch pipe, ¼-inch thick, would require 20 lbs. of Thermit.

A New Automatic Pistol.

THE Swiss military authorities are about to adopt a new automatic pistol in place of the revolver. This is known as the "Parabellum" (a high-sounding name!), and is the invention of Herr Leuger, of the Deutsche Waffen und Munitions Fabriken. It is an improvement on the Borchardt pistol. It has a calibre of 7.65 millimetres (.3-inch), is 237 millimetres long (9½ inches), and weighs 835 grammes (a little over a pound and a half). Its maximum range, when fired at an angle of 27° 30′ is 1,800 metres. At a distance of 50 metres the projectile has penetrated a sheet of iron 8 millimetres (over ¼-inch) thick. With magazines charged, 100 shots can be fired in a minute.

Malaria and the Mosquito.

DR. PATRICK MANSON and Dr. Ronald Ross have established the connection between the mosquito and the parasite of malaria beyond dispute. But controversy first was founded on the assumption that malaria was sometimes found in places where the mosquito was not indigenous. A partial answer to this objection has been supplied by M. Camboulin, who has been pursuing researches on malaria in the Suez Isthmus. He found that the Anopheles mosquito of the Pharvensis variety was sometimes blown by desert winds distances of thirty miles and upwards.

How we Move and Speak.

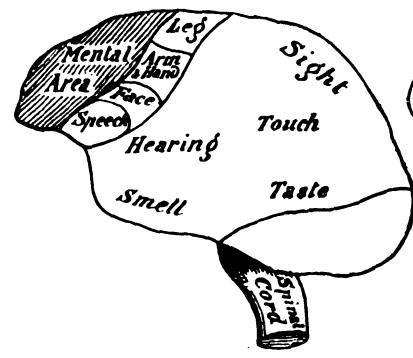
A FEW FACTS ABOUT OUR BRAINS.

FOR what are our brains provided? We imagine the greater number of our readers would reply that they are given us to think with, and beyond that, perhaps, they would be puzzled to put forward a fuller explanation. Certain it is that those who display unusual cleverness are said "to be gifted with 'brains,'" and since extreme ability is more or less associated with deep thought, it must be admitted that our brains are supplied for the purpose mentioned. But there are other reasons for which we are furnished with this part of our complex anatomy, and which, probably, at present beyond the knowledge of the average individual, can be clearly demonstrated, and will be found in the end easy of understanding, and of more than ordinary interest.

The human brain, and the nervous system which is attached to it, has an extremely close resemblance to the ordinary telegraph system as practised in all civilised countries. At first sight this may sound ridiculous, but it is a fact nevertheless, as can readily be shown.

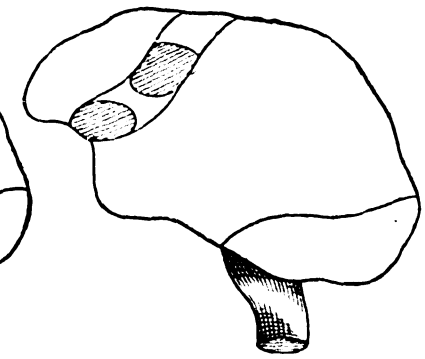
For instance, look at Fig. 1., a diagram of the human brain. The shaded part in front is that portion specially set aside for

Fig. 1.



Left side of brain.

Fig. 2.



Left side of brain, showing highly-educated centres for movements of right arm and hand and for speech.

thinking and for the exercise of the human will, whilst the area behind is reserved for the special functions of touch, smell, hearing, and sight. Between the two will be seen a small strip, and this portion has command over the innumerable and often intricate movements of our arms and legs. More than that, the tiny area labelled "face" controls the various contractions of that portion, and were it not for this, we should be powerless to express joy or sorrow, fear, and the thousand and one phases of our minds, which the face is capable of displaying.

Now for the illustration! Let us suppose we wish to turn over a page of this magazine. What happens?

The thought or wish is developed in the fore part of the brain, and just as a message is transmitted along the telegraph wires, so is this wish flashed by numerous delicate nerve fibres to the area labelled "arm and hand," where it is received. Now, strange as it may seem, this acts as a stimulus to this tiny area, or centre as it is usually called, and the message is again passed down the special nerves running through the spinal cord to the arm, and these in turn cause the muscles to contract harmoniously together and we are capable of grasping the leaf between the finger and thumb, and turning it over at our will.

To read it, it sounds like a lengthy process, but in reality the whole is carried out on the instant, for if it were not so, the human race would rapidly become extinct; we should be incapable of sudden movement, and in moments when instant action would mean the saving of our lives, we should be powerless to escape. Think of it; in travelling on the "Underground," where the train halts for a few moments only, we are able to leave the carriage within that time, but, if our bodies were so constituted that a perceptible interval elapsed between the thought and the carrying out of our wishes, we should have to choose other means of getting about, or else, like the old lady one so often hears of, we should travel round and round till the train halted for the night.

The surface of the brain is like a map, marked out in various areas, which, as has been explained, are each the special centre for some movement of our bodies, and are also, in every case, under the control of that portion in which the mind is situated. The message is conceived by the mind, passed by it to the centre, and transmitted by that small area to the muscles.

Now in the case of "Sight."

This magazine is before your eyes, and its image is focussed at the back of the eyeball. There it stimulates the nerve-fibres, which flash the message (in this case the size, colour, form, &c., of the object before you) to the centre for vision, and from there the image is sent on to the mind and realised by you.

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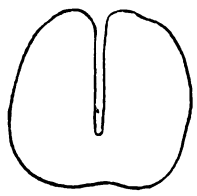
Again in the case of "hearing." The drums of your ears transmit sound to the special centre set aside for this most valuable function, and from there it is sent forward to the mental portion, where, by life-long practice, its nature is understood and in the majority of cases you are able to state exactly what has caused it, as for instance, the notes of a piano, the whistle of an engine, or the blare of a trumpet—who could mistake such familiar sounds?

Now look at Fig. 2. Here two areas only are mapped out. They are the centres for movement of the right arm and hand and for that of speech, that all important gift with which a thoughtful Creator has endowed us, and thereby raised us immeasurably from the common type of animal.

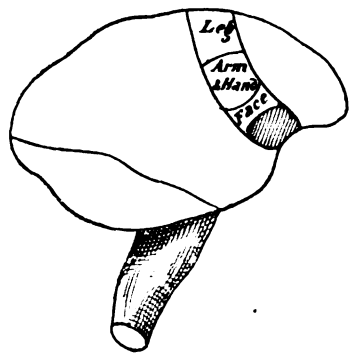
You will notice that only the left side of the brain is illustrated, but a glance at Fig. 3 will show you a cross section, and by it you

Fig. 3.



Transverse section of brain, showing the strip which connects the two halves.

Fig. 4.



Right side of brain, showing uneducated speech centre.

will see that the organ is almost divided into two equal parts, a right and left connected, however, by a narrow strip below.

Now here is one more illustration of the wonderful and marvellous manner in which mankind is put together. You would naturally suppose that your right arm and leg were governed by the corresponding side of the brain, but this is not so, for those nerves which pass from the brain centres to the spinal cord, and thence to the muscles, first of all cross to the opposite side, and thus the right half of the brain works the left side of the body, and *vice versâ*.

In Fig. 2, the area for speech is clearly shown, but a glance at Fig. 4 will fail to tell you where the corresponding centre on that side is situated, and this for an obvious reason, namely, that there is only one speech area, and that is in the left half of the brain.

This is, perhaps, one of the strangest, if not the most singular, of all the interesting points in connection with the organ in question, and one certainly which was only discovered after long continued and laborious research. A scientific examination of the contents of our skulls would demonstrate that, in the very large majority of people, that portion on the right side which corresponds to the centre for speech situated on the left, actually exists, but has no use, and is incapable of controlling any action. But curiously enough, and here probably is the most marvellous point of all, should a man be *left*-handed, then the "speech-centre" will not be on the left, but on the opposite surface of the brain.

From this it will be seen that the side which presides over your function of speech also directs the intricate and wonderful movements of which one hand alone is usually capable, and for that reason it is customary to describe the left half of the brain as more highly "educated" than its fellow.

Now, why should a man be right-handed?

Why, for instance, could not our labours be shared, and if the right were devoted to writing, why should the left not undertake the numerous other movements which our every-day life calls for?

The answer is, that education teaches us to undertake the greater number of our finer labours with our right hands, and thus, simply because it is customary for mankind to be right handed, the practice is passed on from generation to generation without a change. There are those, of course, who are exceptions, and who prefer to use the left hand, but they are few and far between, whilst the number of people who are equally deft and cunning with either hand is extremely small.

That it is in reality a matter of simple education can be proved without a shadow of doubt. Take, for instance, the case of a man who is suffering from writer's cramp. By diligent practice he can finally teach his other hand to wield the pen with a facility not less than that previously acquired by its damaged fellow, and that this is so will probably be in the knowledge of many of our readers.

Then again, a doctor will tell you that it is not an unheard of thing, in fact it is far from uncommon, for a certain injury to the extremely delicate nervous matter in the region of the "speech-centre" to deprive an unfortunate patient of the power of speech, leaving him very much like a new-born babe, but with this difference, that, though speechless, he can comprehend every word addressed to him. Here, the area on the opposite side, which up to this has fulfilled no purpose, comes into action to save him from the awful fate of dumbness. Gradually, little by little, at first lisping like a child, and later with ever-increasing distinctness, it is educated to control the many and diverse sounds of which our lips are capable, and after a long practice will have attained a proficiency which is truly remarkable.

Thus, it is clear, that though two areas of brain are supplied at birth, only one is educated, and into this small space are crammed all the powers of speech, governed, it must be recollected, by that mental portion which controls the whole.

Why that side of the brain which controls our speech should invariably be also the master of our more useful hand we cannot state, no more than we could tell you the exact source of this wonderful life of ours, but that the statements and facts related are substantially correct we have no doubt, and they will, we feel sure, convince you that your skull is more than a simple "thinking box" and enable you to answer more completely that question with which this article opened.

Recent Meteorites.

THE fall of a meteorite is so rare an event in these islands that the descent of one near Belfast in September was felt to be an event almost as important as the British Association, the occurrence of which it seemed to signalise. The meteorite, however, could at any rate claim to be of rarer occurrence than the annual scientific meeting, for it was the largest stone that had been seen to fall from the sky to the British Isles for eighty-nine years. It was 9 lbs. 5½ ozs. in weight, and 7½ ins. by 6½ ins. by 3½ ins. in dimensions. Such dimensions, though not very much larger than the combined brains of the Presidents of the Astronomical, Physical, and Mathematical Sections, are considerable for a British meteorite, but they are very small in comparison with the meteorites of Mexico, one of the largest of which has lately been carefully examined, and its dimensions and material scientifically estimated. The great Bacubirito meteorite was, before examination, nearly embedded in the earth where it had fallen. Its dimensions, now that it has been dug out, are 13 ft. 6 in. by 6 ft. 2 in. by 5 ft. 4 in., and it is shaped like a ham. In structure it is eminently octahedral, and seven per cent. of its constitution is nickel. It has suffered very little from oxidation: the pittings are clean and well marked. Five others of the great meteorites of Mexico, which seems to have been a happy hunting ground of these ex-territorial bodies, have been transferred to the Mexican School of Mines, where it is hoped that the Bacubirito meteorite may follow if the expense of transport be not too great. This meteorite, however, is probably not so heavy as the great meteorite of Sinaloa which was found in 1876, and is estimated at a weight of fifty tons: and possibly not quite so heavy as the great Anighito meteorite which Lieut. Peary found in Greenland. Other great "world meteorites" are the five-and-a-half tonner of Bendego, in Brazil, the 11½ ton meteorite of San Gregorio, and the one at Chapandas, of about the same weight. Another curious meteorite, the report on which has just been presented by Wilhelm Ramsay and L. Borgström, is called the Bjurböle meteorite and fell into the Bjurböle Fjord about 30 miles north of Helsingfors. It smashed through the ice with which the fjord was covered and embedded itself in the mud to the depth of six mètres. Fortunately, the water was very shallow, and 328 kilogrammes weight of the meteorite was recovered in fifty pieces. This meteorite may at any rate be regarded as having certified its own origin.

Europium—A New Element.

To the "Chemical News" M. E. Demarcay contributes an account of the researches which led up to his discovery of the new element "Europium." The spectroscopic experiments of Sir William Crookes in 1885 indicated an element which was akin to "Samarium," and it is the faithful pursuit of Sir W. Crookes's "anomalous line" on the spectrum which has now resulted in the isolation of "Europium," the atomic weight of which is 151.

Suicides in France.

RECENTLY-published statistics, not, however, bringing the subject quite up-to-date, show that the number of suicides in France in 1900 has declined from the alarmingly high figures of the few years before. The figures given are as follows:—

1881-85	average	7,339	suicides or	19	per 100,000 inhabitants.
1886-90	„	8,286	„	21	„
1891-95	„	9,237	„	24	„
1896	„	9,260	„	23	„
1897	„	9,356	„	24	„
1898	„	9,438	„	24	„
1899	„	9,952	„	25	„
1900	„	8,926	„	22	„

The average of recent years shows the proportion of male and female suicides to be 7,069 men and 2,017 women.

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Another Hodgkins Gold Medal Awarded.

IN March last, Secretary Langley, of the Smithsonian Institution, appointed a Committee to consider whether any discovery had been made since the award of the first Hodgkins Gold Medal in 1899—under the general terms of the gift "the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man"—which would render it proper that such a medal should be again awarded. This Committee consisted of the following distinguished men of science: Mr. Richard Rathbun, Assistant Secretary of the Smithsonian Institution, Chairman; Dr. A. Graham Bell, for Electricity; Dr. Ira Remsen, for Chemistry; Dr. Charles D. Walcott, for Geology; Professor E. C. Pickering, for Astronomy; Dr. Theodore N. Gill, for Biology; Professor Cleveland Abbe, for Meteorology; Mr. William H. Holmes, for Anthropology, and Mr. S. W. Stratton, for Physics.

Owing to the absence of Mr. Rathbun, Dr. Remsen served as Chairman at a meeting of the Committee held at the Smithsonian Institution in Washington, April 15th, 1902. At this meeting the following resolution was unanimously adopted:—

"That the Committee recommend to the Secretary of the Smithsonian Institution that it is desirable that one of the Hodgkins gold medals be struck, and that it be awarded to J. J. Thomson, of Cambridge, England, for his investigations on the conductivity of gases, especially on the gases that compose the atmospheric air."

The finding of the Committee being approved by the Secretary, steps were at once taken to have the second Hodgkins gold medal struck under the personal supervision of its designer, Monsieur J. C. Chaplain, of Paris. The medal (shown in the accompanying photographic illustration) has recently been received by the Institution and has been dispatched to Professor Thomson through the Department of State.

The Observer of Earthquakes.

EARTH TREMORS AND VOLCANOES.

IN a despatch addressed some days ago to the Colonial Secretary, the Administrator of St. Vincent remarked that "the rumbling and detonations were, I think, greater than on any previous occasions," and it is plain, according to the rest of the reports, that the destruction was as great as the noise. And, again, the Governor of the Windward Islands writes, "It is a matter for grave consideration whether any part of the island can confidently be said to be without the range of danger from this terrible volcano." In short, it is feared that La Soufrièr and Mont Pelée will again break out. They probably will. The one hope is that their activity will be restricted in violence. According to Professor John Milne, F.R.S., the primary cause of the volcanic eruptions in Martinique and St. Vincent was a settling in the great rock-foid of the Antillean ridge. Nearly all active volcanoes, Mont Pelée and La Soufrière among them, occur along the ridges of rock-folds which are in proximity to oceanic waters. By the percolation of this water to the foundations of these folds, where it comes into contact with molten matter, extraordinary pressures of steam are developed, the sudden relief of which results in a volcanic outburst. One can imagine a state of extraordinary pressure such as we have described suddenly precipitated to the bursting point by even a slight movement in the rock-fold where it exists. Now, following a great earthquake, there are a number of small earthquakes, children and grandchildren of the first, along the lines of its displacements. For instance, after the great disturbance of October 28th, 1891, which had its origin in Central Japan, and which may be regarded as a typical world-shaking earthquake, during the first twelve months 2,956 shocks were noted. In the year following this number had decreased

The Hodgkins Gold Medal.

Weldable Steel.

MR. A. J. LUSTIG, of Newark, New Jersey, claims to have found a new process in casting steel, which, if it proves to be practicable, should be of the greatest importance. In ordinary methods of casting, blowholes and spongy steel are often produced owing to the presence in the mould of atmospheric air. Not the least of the troubles due to this cause is the charging of the ingots with nitrogen, which hinders welding operations. In Mr. Lustig's process hydrocarbon gas or vapour is stored around and under the covered mould. When the filling of the mould begins, the superheated hydrocarbon vapours enter, thus displacing the atmospheric air. After the mould is filled it is covered, and the hydrocarbon vapours are caused to pass through the steel in order to force outwardly whatever atmospheric air has entered. From tests which have been made it would seem that there is an increase in the merchantable quantity of steel obtained of 15 to 40 per cent. Steel made by this improved process has a tensile strength of 145,000 pounds, in contradistinction to 125,000 pounds at present obtained. The elongation of the new steel is 4.60; that of the old 1.09. The chief merit of the new steel, however, is to be found in the fact that it is most readily weldable.

to 391. These minor disturbances are, naturally, of greatest violence in the neighbourhood of the great rock-fold, the subsidence or alteration of which produced the first earthquake. They sometimes can only be felt over an area of a few square miles; they may be felt over much larger areas. These small disturbances do not, of themselves, bring dormant volcanoes into a state of activity—that can only be done by the large primary earthquakes—but they may evidently contribute to keep the volcanoes in a state of activity for some time. The number of such tremors has been calculated by Professor Milne at about 30,000 yearly.

The number of large earthquakes to be distinguished as world-shaking earthquakes, or disturbances whose tremors can be detected at seismological stations all over the world, is, of course, very much smaller. These great convulsions have their origin in regions where a great continental mountain range slopes steeply down to the sea. There are eleven such world-earthquake districts. There is the Alaskan Region, where, on the shore, Mont Elias rises to a height of 18,000 feet, and where the water is 7,000 feet deep sixty miles from shore, altogether a descent of 25,000 feet in 200 miles; and this, without going into measurements, may be taken as typical of the rest, which are classified as the Cordillerean region, the Antillean region (in the earthquake district of which Martinique and St. Vincent are

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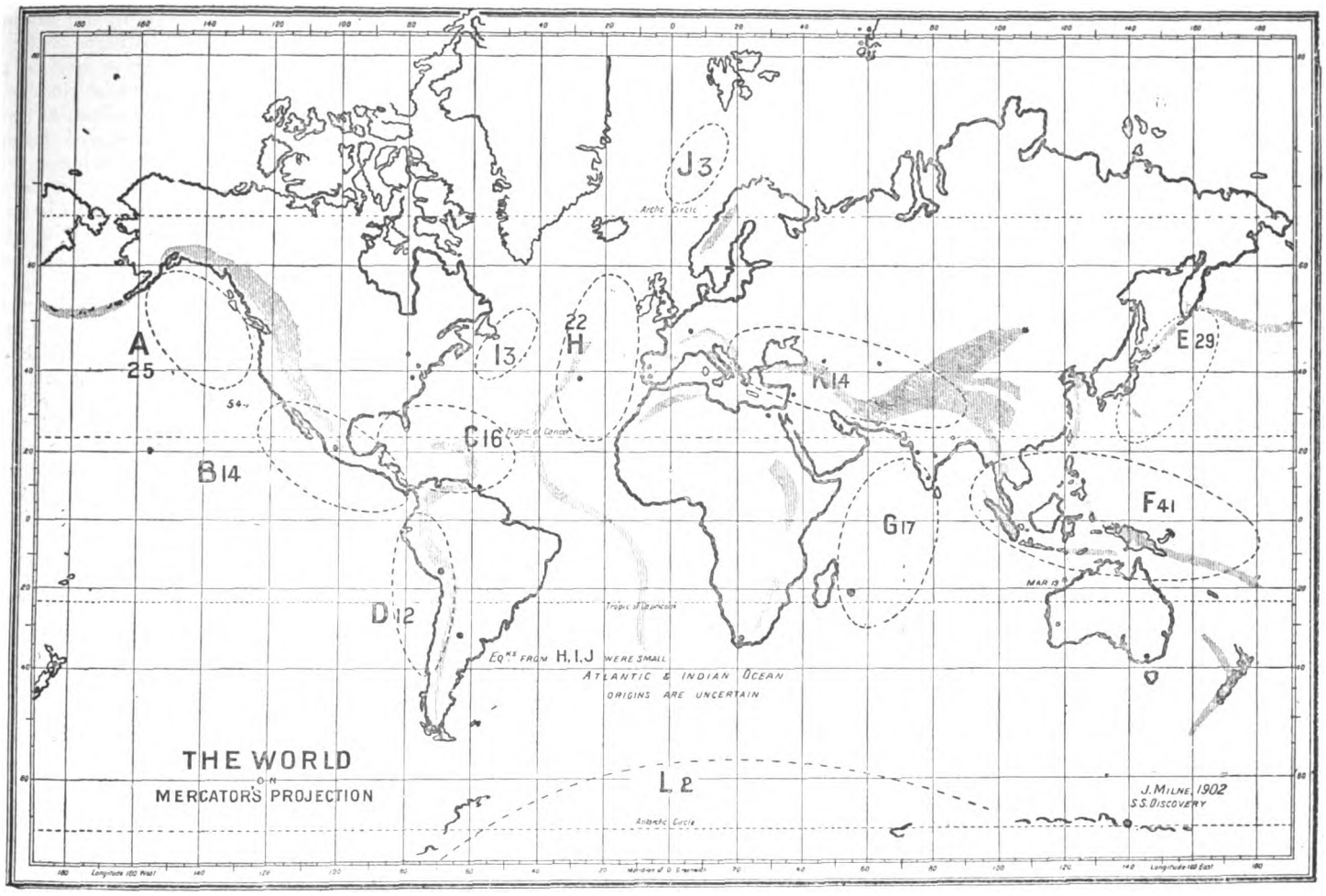
situated); the Andean district, its continuation; the Japan district, the Javan district, the Mauritian district; three submarine districts of sunken ridges in the North-Eastern, the North-Western, and North Atlantic respectively, and one great land district, distant from the sea, which lumps together all the mountains of the Alps, the Balkans, the Caucasus, and the Himalayas. The mechanical theory of the production of earthquakes by these masses may be taken as due to the enormous pressure of the superincumbent strata upon the lowest lying strata—a pressure which may be so great as to cause the lowest strata to "flow," as iron can be shown to flow under great pressure. The great heat, the conditions of strain at these unexplored depths can only be imagined; and theory can easily run wild in dealing with them. But from whatever causes sprung, it is certain that the great world earthquakes come from these districts; and in the years 1899, 1900, 1901, there were 196 earthquakes, extending all over the world, which began there.

For the detection of the tremors caused by their earthquakes, as well as for investigating the smaller tremors, their sources, and their cause, the Milne seismographs are now set up in Observatories all over the world; in Africa, Australia, Canada, Ceylon, Egypt, Germany, the Pacific, India, Japan, New Zealand, North and South America, and all the countries of Europe. There are, altogether,



Map showing the Epi-focal districts of great Earth tremors.—The dotted lines enclose the areas of primary disturbance.
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some fifty of the instruments designed by Professor Milne for recording the tremors set up at the world's observatories. The "seismograms" traced by these instruments—that is to say, the more important of them—are sent from all over the world to Professor Milne's central observatory at Newport, Isle of Wight, and from these a chart of the world's earthquakes can be deduced. The information required from a seismogram is the date on which it was obtained, the Greenwich mean times for the beginning of motion, of decided motion, and of the greatest motion. From these data the origin of the shock from the observing station may be inferred. A detailed description of Professor Milne's earth-tremor measuring instrument is, perhaps, superfluous. Suffice it to say that it consists of a light aluminium boom, or horizontal pendulum, which is based on concrete or rock, and which the movements of ordinary traffic do not disturb. The movements of the pendulum or boom caused by earth tremors are, however, recorded automatically, on a strip of bromide paper, on which such movements are photographed. The bromide paper is driven by clockwork past a slit, and the boom ordinarily photographs itself as a straight line on the moving strip. An earth tremor causes the straight line to break into zigzags or waves, and thus registers itself photographically. The instrument is extremely sensitive, so sensitive that currents of air in its neighbourhood may disturb it. But the most convincing proof of its sensitiveness is that it records earth movements made by alterations in barometric pressure; so that, in California, a storm-centre approaching from the Pacific can be foretold by its deflection.

Our Food Supply and Motor Cars.

PESSIMISTS have been wont to cry out about the danger to this country in the event of war, owing to the quantity of wheat grown being wholly insufficient to supply the needs of the population. But now we hear of a suggestion that, instead of this bug-bear growing worse in years to come when the population will have increased, it will gradually disappear! This remedy is to be found in the increasing use of the motor car! According to the most recent statistics we have in Great Britain, 1,726,473 acres under wheat.

But as regards oats, we have getting on for double as much, viz., 3,057,203 acres, while of grass land we have 16,806,514 acres. Now comes the question of what all this oats and grass is used for, and the answer cannot but be that by far the greater part of the former and a good deal of the latter are for the forage of horses. But if the motor-car is to oust the horse entirely, there will be no use for these large quantities of oats and hay. It is true that the land on which these are grown may not be as suitable for wheat-growing as for their present purpose, but if otherwise lying idle, wheat *could* be grown on most of it. If then, in years to come, the demand for oats and for hay be so materially lessened, it seems possible that the acreage under wheat could be doubled or trebled.

There are said to be 2,000,000 horses used for agricultural purposes alone in England. Allowing each of these an average of 6 lbs. of oats a day, a total consumption of 2,000,000 tons per annum is arrived at; or, to put it in simpler figures, it may be said that a horse eats about 6 or 8 times as much corn as a man. Therefore, the food of 5,000,000 horses would be about equivalent to that consumed by the whole human population of Great Britain. The amount of grass and hay now devoured by the horses could be apportioned to the extra cattle and sheep to augment the meat supply.

New Method of Transmitting Telegrams.

A NEW invention is now undergoing practical trial for transmitting telegraph messages between the General Post Office in London and Edinburgh more rapidly. The inventor is Mr. Donald Murray, an Australian, who has already installed the system in America, and has it now on trial in Germany. The message to be sent is placed before an operator working a machine very similar to a typewriter, but which punches small perforations in a ½-inch paper tape which is passed through the machine. When the message is thus transcribed, the type is fed into the telegraph instrument and the perforations in Morse code transmit the message by the well-known method. In this way 100 words per minute can be transmitted, which may be duplicated. At the receiving station the tape is taken to a machine worked by hand; the message is typed in ordinary writing.

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The Nile Dams.

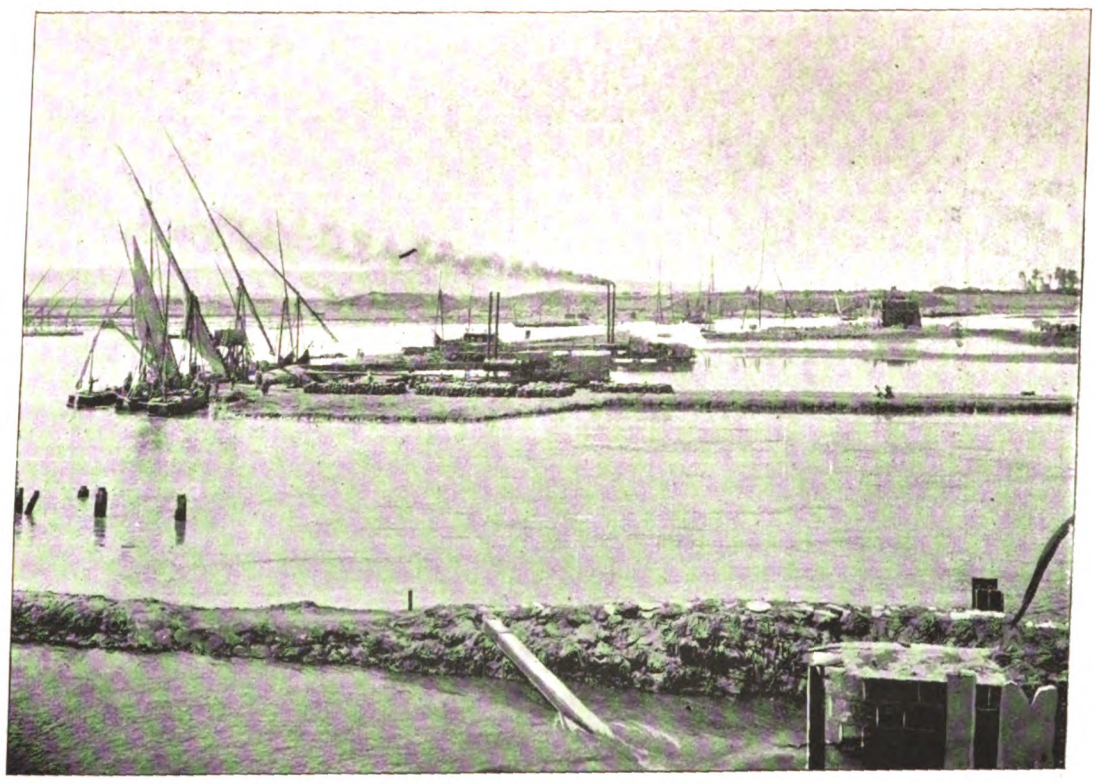
Assouan and Assiout.

BY E. S. GREW.

PROBABLY no great engineering work ever undertaken has been carried out with such punctuality, and with such certitude, as that which is now completed at Assouan, and which, best known as the Great Nile Dam, will be formally opened by the Duke of Connaught on the 10th of this month. The contract for the work was signed in February, 1898. The dam was to be finished in five years; to be exact, its completion was fixed for July, 1903. It is, therefore, some eight months ahead of its time. Nor was the expedition of the dam's construction owing to the absence of difficulties—of unexpected difficulties. In the preliminary reports of the foundations at Assouan on which the dam is built, it was said that there was an extensive crop of syenite and quartz diorite clean across the valley of the Nile, giving sound rock everywhere at a convenient depth. As it turned out, the rock proved to be unsound in many places to a considerable depth, with schistous micaceous masses of a very friable nature. In consequence, a dam, which was nearly 100 feet in width at its base, had to have its foundations deepened at some points by forty feet more than had been calculated. One of these gaps—a kind of rotten tooth in the foundations—is shown in an accompanying illustration. But the scheme of the dam was so sound, that, like the great plan by which Lord Roberts relieved Kimberley and trapped Cronje at Paardeberg, mistakes in detail were powerless to wreck it. How magnificent a work it was and is will be shown by the mere statement of the dam's dimensions.

Dimensions of the Dam.

From bank to bank of the Nile it stretches a mile and a quarter, spanning the islands and channel rapids which formerly constituted the First Cataract. Its top is twenty-four feet wide, and a roadway seventeen feet wide runs between its parapets. It is not, however, a straight wall flung across the river. Its sides are not parallel; the down stream side slopes away to afford stability; so that its average width at the base is sixty-two feet. The average height above foundations is eighty feet. But, as already observed, when the engineers have had to go deeper to find solid rock, the width at the base increased with the depth, so that at some points where the foundations are 130 feet deep, the base is more than 100 feet wide. Broadly speaking, one may estimate the cubic contents of the dam at 25,500,000 cubic feet. But whoever thinks of the dam at Assouan must think in large figures. The difference of level between the water above the dam and the water below is 67 feet. For 150 miles above the dam the Nile will feel the effect of this bridle; and the whole quantity of water held up will amount to 1,000,000,000 cubic metres of water. That was the estimate of Mr. Willcocks, who first conceived the plan and the site of the dam. Sir Benjamin Baker, who first drew the amended and finally accepted plans for the dam, suggested an interesting comparison which helps to charge these figures with meaning. Some time ago, he remarked, the engineers of the London County Council drew up a scheme, called by some people a "colossal project," to supply London with water when her population should be double what it is now. Reservoirs were to be constructed in every reasonable available valley in Wales to store up water for London. Well, the united contents of the whole of these reservoirs would be less than half that of the great Nile reservoir. Again, the Nile reservoir would hold more than enough water for one year's full domestic supply to every city, town, and village in the United Kingdom with its 42 million inhabitants. But possibly the best way of giving an idea of the magnitude of the work and its utility to a thirsty land is by considering the volume of the water issuing from the Reservoir during the three or four summer months when scarcity of supply prevails in the river and the needs of the cultivators are greatest. At that time the flow from the Reservoir will be equal to a river double the size of the Thames in mean annual flood condition.



The Barrage at Assiout.

Method of Irrigation.

In the last sentences is contained the germ of the uses to which the dam is to be put, and the means by which its accumulations are distributed. Egypt is largely desert. It is fertile by the banks of the Nile alone. Thousands of years ago when the great Israelite Joseph stood before Pharaoh, he constructed reservoirs and canals which conveyed the Nile's beneficent waters to the lands by the side of the river; and the object of all Nile reservoirs and barrages is the same as his, which is to widen the fertile strip of irrigable land on either side of the river. At high Nile all the irrigation canals in this strip are filled; at low Nile they will run dry. The Great Dam at Assouan will dole out the supply of water which it has captured during the winter months to the irrigable lands of Upper Egypt during the dry months of the summer. Assouan and its dam are 600 miles above Cairo. Some 350 miles lower down the river is the great barrage at Assiout which is to dole the water out again—to farm it out, one might say—after it has come down from Assouan. The barrage at Assiout, which is supplementary to the upper dam, is, itself, a formidable engineering work, though neither in difficulty of construction nor in dimension is it comparable with the work at the First Cataract. The total width of this structure is 2,750 feet, or rather more than half a mile, and it includes 111 arched openings of 16 feet 4 inches span capable of being closed by steel sluice gates 16 feet in height. The object of the work is to improve the present perennial irrigation of lands in Middle Egypt and the Fayoum, and to bring an additional area of about 300,000 acres under such irrigation by throwing more water at a higher level into the great Ibrahimiyah Canal, whose intake is immediately above the barrage. The piers and arches of the Assiout barrage are founded on a platform of masonry 87 feet wide and 10 feet thick, protected by impermeable piling and stone. As at Assouan, a roadway runs across the top of the barrage, which is 41 feet above its masonry floor. Within limits, the method of construction of this lower barrage was similar to that at Assouan, to be presently described; but the difficulties were not nearly so great, and the only one common to both dams or barrages was that during part of the year, when the flood comes down between July and November, a great deal of the work had to be suspended.

Sudds and Dam Making.

At Assouan, the First Cataract of the Nile, before it was abolished by the dam, consisted of a number of turbulent channels running between rocky islands. There was one considerable channel near the eastern bank from which operations were begun, but the biggest and swiftest channels were towards the western bank—the Bab el Kebir, the Bab el Sogair, and the extreme Left Channel. Many plans were considered by the engineers and the contractors, Sir John Aird and Co., for putting the foundations of the dam across the roaring Cataract channels, and it was finally decided to form temporary rubble dams across three of the channels below the site of the great dam, so as to break the force of the torrent and get a pond of comparatively still water up-stream to work in. Stones of from one ton to twelve tons in weight were tipped into the cataract, and this was persevered in until finally a rubble mound appeared above the surface of the water. The first channel was successfully closed on May 17th, 1899, the depth being about 30 feet and the velocity of the current nearly 15 miles an hour. The last channel was not closed until two and a half years later. The work was extremely interesting, and was described to the writer by Mr. John Blue, the engineer for Sir John Aird and Co., as follows:—From either side

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THE GREAT NILE

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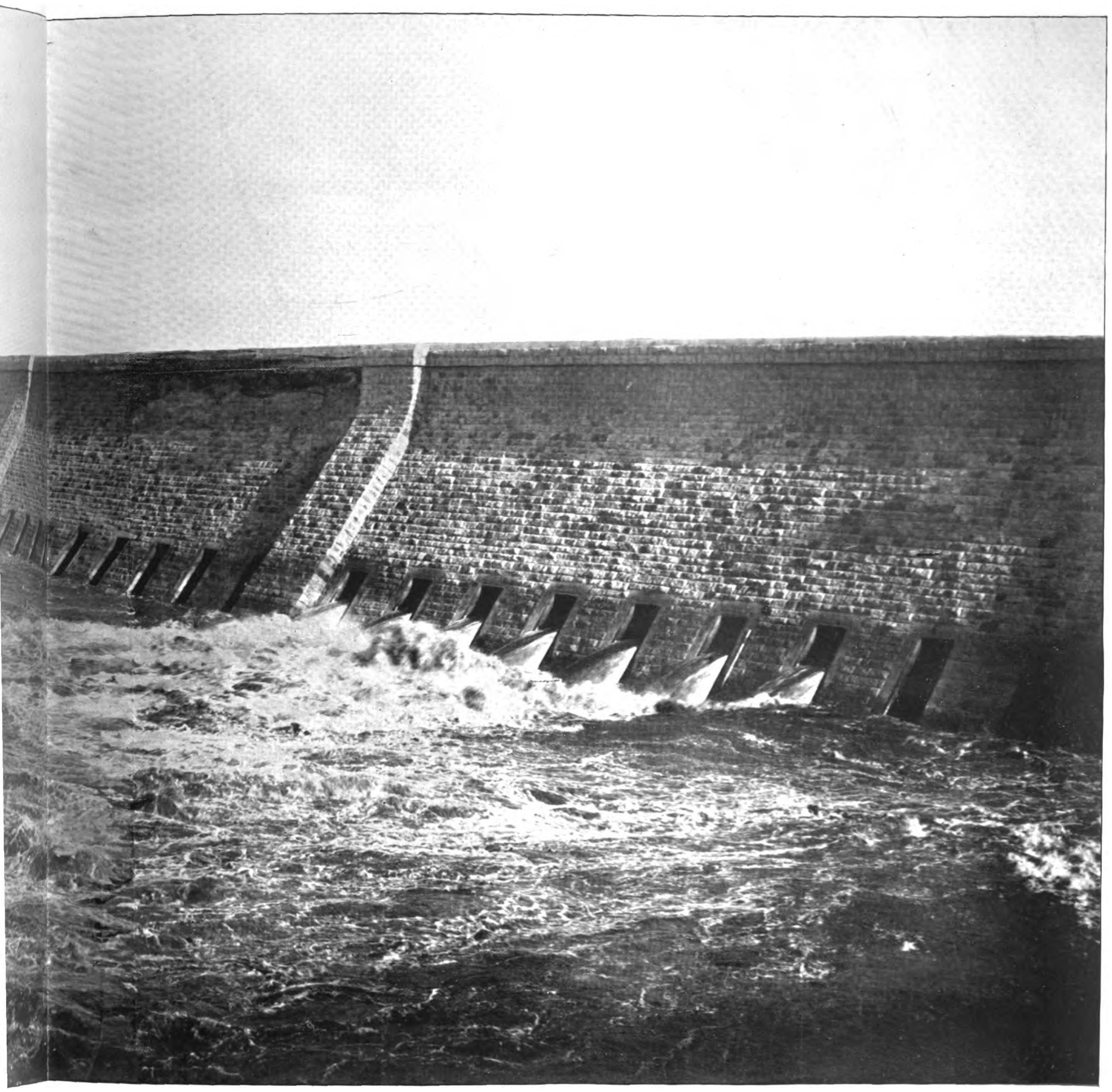

EAT NILE DAM.

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One of the Quarries.

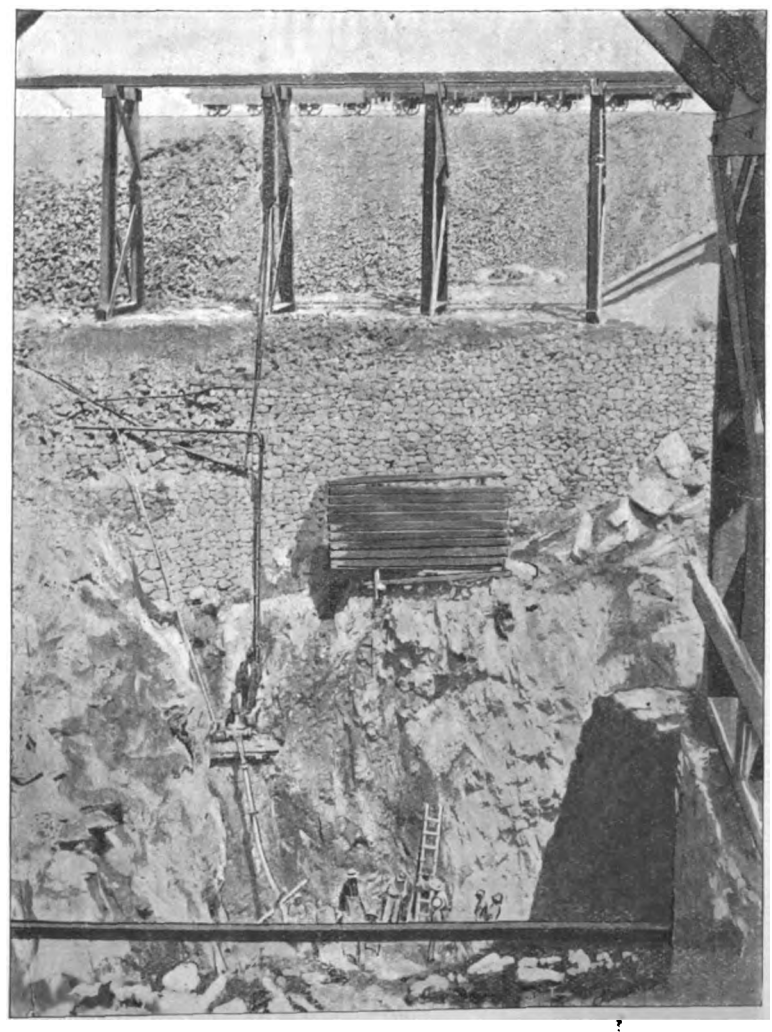
of the channel a stone sudd or breakwater was built out into the stream. Great nets of steel wire shaped like a cross with sharpened ends were made, and in them were laid five-ton blocks of solid granite. Then the four pointed corners of the cross were gathered together and the netful of granite was picked up by a travelling crane and dropped into the channel. This went on until a breakwater was built across the channel below the line which the dam was to take. Towards the close of its construction, railway trucks were filled with granite blocks, and with a flying start imparted to them by a locomotive, were shot into the stream, trucks, stones, and all. The Great Western Channel swallowed a good many of these before it showed signs of repletion. When, at length, a stone sudd stretched across the channel, it was given what is called a "staunch" of sand or cement, which is to say, that along its up-stream side, large quantities of sand were dropped, which filtered into the stone sudd and filled up the interstices. After this, a sand-bag sudd was constructed further up-stream in the comparatively still water, which the building of the stone sudd had brought about. Above the line of the dam thousands of sandbags were sunk until this sudd became as impermeable as the stone one below. An illustration of this method can be seen in the Assiout photograph. Last of all a smaller sudd was built below the stone sudd to prevent water from flowing back again, and the water was pumped out from between the two primary sudds, the sandbag and the stone. In the dry channel thus formed, excavations were begun, and foundations were laid.

When flood-time came, all the works in the channels were necessarily suspended, though work could be continued on the islands. The Nile's force at flood-time may be best apprehended from the remark that after the subsidence of the flood, steel rails were found swept away or twisted like string, and all the masonry of the dam over which the sandy water had swept was found smooth and polished like marble. In the flood season, the dam was built up on the islands, and work with the lock channels could be proceeded with. These great lock channels will secure free navigation for steamers. Navigation channels on each side of the dam, north and south, will give access to the locks which are on the western side of the river, and will protect vessels from the rush of the waters. These huge cuttings are deeper and longer than the space between the houses in most London streets; and description scarcely conveys an idea of them. But figures will convey something. When the chain of locks is completed it will link four locks, each 270 feet long and rather more than 32 feet wide. Collectively, they will lift or lower vessels about 67 feet. Now for the working of the dam. It is pierced by great sluices of the type used on the Manchester Ship Canal. There are 180 of these, arranged in groups of tens, with massive buttresses in between the groups for strength. Of the 180 sluices, 140 are 24 feet high by a little more than 6 feet wide. These are the sluices which are placed where the Nile channels were. Forty smaller sluices 12 feet high by 6½ feet wide are placed at higher levels on the islets, and will be used for regulating the flow of the Nile when it becomes desirable to allow the stored-up waters to flow away. All the sluices are capable of being worked by hand, though hydraulic power will probably be made use of to move them. At high Nile the whole of the flood will pass through the sluices by the dam at the rate of 15,000 tons of water a second—or much more than the whole reservoir-full in the day—but will never submerge the dam itself. At the subsidence of the Nile the dam will hold up a lake running as far up as Korosko, and more than a mile wide in many places, and this lake will be gradually allowed to slip out through prescribed numbers of sluices. In addition, navigation for steamers will be extended to Wady Halfa, nearly 800 miles from Cairo.

Designers and Workers.

In Egypt the first great credit for this work is given to Mr. Willcocks, the Director-General of Reservoirs, at a time when neglect and corruption made the carrying out of such a work appear only a dream. For years he hammered at it, personally inspecting every yard of the Nile Valley and tramping the adjoining deserts for hundreds of miles under circumstances often of great hardship. At last, however, after many months and years in which he must have despaired, he had the satisfaction of seeing his plans backed up by his official chiefs, and reinforced by the support of the financiers. Sir William Garstin and Sir Edward Cassel must be honourably mentioned in this connection, but not more honourably than the firm of Sir John Aird and Co., who accepted the contract for the work, and their engineer, Mr. John Blue, who carried it on, upon the plans framed by Sir Benjamin Baker, as consulting engineer. There are, besides these, all the unconsidered rank and file, "the supers and the shifters," who have had a hand in the work. When both dams were in full swing at Assouan and Assiout, nearly 11,000 workmen were employed. Of these, 8,000 were the Arabs who live in, or about, the towns and villages which the great dam has created; and they furnish what might be called the unskilled labour. There were also 2,000 Italian granite cutters, and the whole of this army was supervised by British foremen. Materials for the dam were gathered from more than 100 quarries, a number of them situated on various islands three or four miles up-stream.

The photographs illustrating the article are lent by Messrs. Aird and Co.



Deep Foundations.

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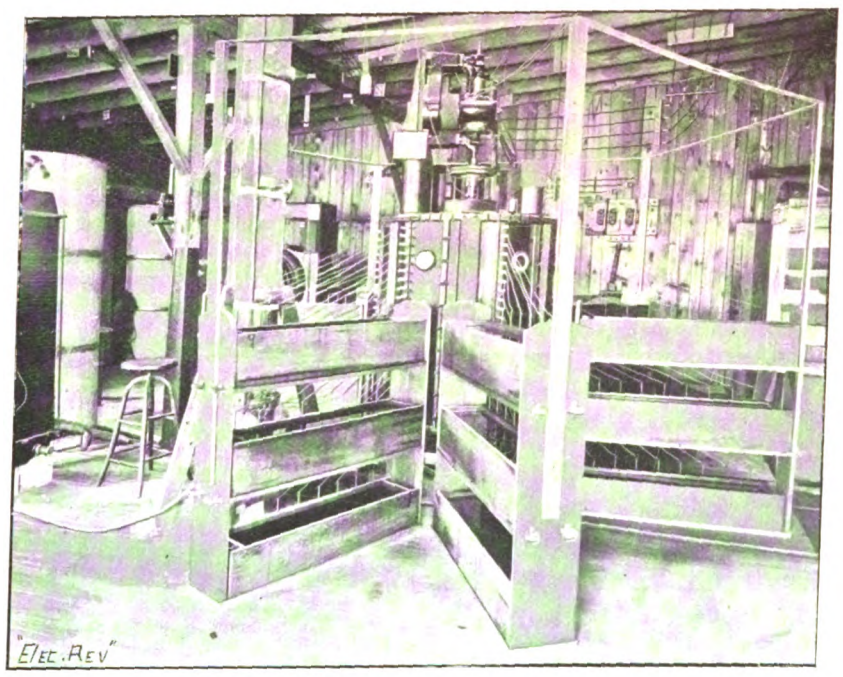
Produce of the Air.

NITRATES BY ELECTRICITY.

ONE of the great problems which the twentieth century will have to solve will be the formation of nitrates in order to stimulate vegetable growth. The consumption of the nitrates which Nature has provided is at present enormously in excess of the supply. Every time a crop of wheat is reaped, every time a salvo of artillery is fired, an amount of nitrate is consumed which Nature can only, or does only, renew with extremest slowness. In a naval battle when, as it has been calculated, some 380 tons of nitrogen, equivalent to 2300 tons of nitrate of soda, are blown off, man is liberating what it has taken millions of minute organisms patiently working for centuries to win from the atmosphere. But the chief importance of the problem is with respect to the world's food supply. The wheat which supplies the great majority of the inhabitants of the world with the most necessary article of their food, helps to exhaust the world's stock of nitrates; and yet the growth of wheat is approaching inadequacy. In 1931, the world's bread-eaters will require 3,357,000,000 bushels of wheat. But on the most liberal estimate the wheat-producing lands of the earth at their present rate of production can only supply 3,340,000,000 bushels—a deficiency of 17,000,000 bushels, which will either have to be filled up by some other form of food, or else will have to be remedied by some increase in the productive powers of the land. The productive powers of the land can be increased by supplying the ground with nitrates—with fixed nitrogen as we may



The Cylinder with Electric Contacts for producing artificial Nitrates.

prefer to call it. The world's supply of fixed nitrogen is largely in the form of Chili saltpetre, an article the supply of which is being exhausted so rapidly that it is said that only some thirty years' supply remains. By the year 1931, however, unless some other means of improving the wheat-growing properties of soils are found, some 1,200,000 tons of nitrate will be required to make the wheat supply keep pace with the demand of bread eaters.

What are the remedies? One which we will not pause at this point to examine, is the stimulation of the roots or seeds of crops with what have sometimes been called the "Nitrogen bacteria." These bacteria, often found about the roots of leguminous plants, have the property of so stimulating the growth and development of their hosts the plants, that these plants become able by themselves to draw raw nitrogen as food from the atmosphere. This discovery and the investigations which have followed upon it in Canada and Germany are yet in their infancy; and we can do no more than allude to it. The other method is that of artificially creating nitrates by "fixing" the free nitrogen of the air. This can be done in a crude way, as was suggested some years ago, and as Lord Rayleigh showed in a repeated experiment at the Royal Institution last year, by burning air—or, rather, the nitrogen in the air—between the poles of an electric arc. It has been suggested that this method might be utilised commercially; and after many experiments, it is being so utilised near Niagara Falls. Briefly stated, the method is that of "striking" an electric arc—a proceeding not unlike striking a match—and then withdrawing the poles of the arc one from the other so as to draw the flame out. In this flame the nitrogen is burnt and a nitrate is produced which can in various ingenious ways be collected. Imagine the arc or arcs thus operating on the atmospheric air, or a regulated mixture of the nitrogen oxygen of the air, in a closed chamber. A fresh supply of air is continually pumped into the chamber; and is withdrawn after passing through the creating electric flame. Thence it is taken into a scrubbing tower about 25 feet high; and in what we may call its nitrogenously concentrated condition forms nitrates with various substances ready to receive it.

The chamber, or apparatus where the air is thus treated in its passage through the flame of electric arcs, is well shown in the illustration. It is of iron, standing 5 ft. high, and is about 4 ft. in diameter. Attached to the sides there are six rows of wires which go inside, twenty-three wires to a row. Inside these form 6 × 23 poles of 138 electric arcs. But this number of arcs can be greatly multiplied: because inside the chamber is an axis with revolving arms. There are 23 of these radial arms. As the axis revolves these radial arms come successively into electric contact with the 138 poles of arcs that we have just spoken of. Thus an electric arc is "struck" every time a radial arm comes into contact with a wire connection, and the arc is drawn out as the axis of the central shaft revolves. Altogether several thousands of arcs are thus "struck" and drawn out every minute, and thus flames are produced in which the air is burnt. There are 6900 arcs "sprung" or "struck," and each arc lasts about one 20,000th of a second. The theoretical output is 1 lb. of nitric acid per 7 H.P. hour of energy used.

Segregation in Steel Rails.

AT a meeting of the Society of Engineers held at the Royal United Service Institution, Whitehall, on Monday evening, November 3, 1902, Mr. Percy Griffith, President, in the Chair, a paper was read on "The Effect of Segregation on the Strength of Steel Rails," by Mr. Thomas Andrews, F.R.S., M. Inst. C.E., F.C.S.

The author observed that in the course of his wide experience as consulting analytical chemist and metallurgical testing engineer to several English railway companies, he had had exceptional opportunities of studying some of the sources of weakness leading to the fracture of steel rails. In order to more fully investigate on a large scale some of the causes of the loss of strength in such rails he undertook the present research on the effect of segregation on the strength of steel rails. In the course of his paper the author treated of the nature and primary causes of segregation in steel rails, and demonstrated by elaborate chemical, physical and high power microscopic experiments the influences of local transverse and longitudinal segregation on the loss of strength in such rails. The position of the maximum area of segregation was also demonstrated in course of the paper. He observed that the microscopic portion of the investigation had further specially indicated some of the latent sources of weakness which occurred in segregated steel rails leading to their premature fracture in main line service. The methods of detecting segregation were also explained and illustrated.

Reference was also made by the author to the importance, in the interests of public safety, of detecting and eliminating from service, as far as practicable, rails having a tendency to segregated chemical composition. The author has, in course of his experience, examined many rails which have fractured in main line service, in tunnels, on bridges, and on other parts of the permanent way, and he has been able in many instances to trace the cause of these fractures to local segregation of some of the chemical constituents which has led to premature physical weakness in the mass structure of the rails when under the vibratory stress caused by heavy traffic.

It has been generally assumed that the chemical and physical properties of steel rails are fairly uniform throughout their longitudinal and transverse mass structure, but the author has shown in this research that such is not uniformly the case. Hence the importance of eliminating, in course of manufacture, as far as practicable, any tendency to local segregation in steel rails, which leads to non-homogeneity of structure.

Some idea of the magnitude of the experiments will be obtained when it is stated that they have taken nearly seven years to carry out, and that in the course of research complete chemical analyses, physical tests and high power microscopic examinations have been made on a very considerable number of steel rails, the samples experimented upon having been selected from large bulks of rails as supplied to various railway companies. The general results of the research have shown the importance, in the interests of the public safety, of railway companies having careful chemical, physical, and microscopic tests regularly made on rails, selected from the bulk after delivery to the railway companies, prior to their going into main line service, so that a tendency to a locally segregated chemical composition may be detected and avoided. Much may be done in avoiding a segregated condition in rails by having them made in accordance with the author's chemical and physical specification and tests.

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London Fog.

The Smoke Contribution.

It is as yet too early to congratulate London on the absence of fogs in this winter, because we are only now approaching the months in which the incidence of fog in London is greatest. Over an average of sixty years December has proved to be the foggiest month; and November, despite its bad name, makes a third to January, and is only slightly more foggy than February. That this is what is to be expected, a very short consideration of the causes of fog in the Thames Valley will show. Wind, the least breath of it, is fatal to fog; although there may be a slight movement of the air during a fog, which, while sufficient to drift it from place to place, will not disperse it. The ideal condition for a fog is then an anti-cyclonic condition in which the centre of the anti-cyclone is somewhere over the south of England—the nearer London or the south-east counties the better—and which produces "calms and variable airs" over London. With the anti-cyclone must come cold weather, especially cold nights; the colder the better—or the worse! The fog is then formed in the night or early morning as follows. It forms over great open spaces like the parks; especially over the lakes of the parks, where the cold surfaces condense moisture. The "variable airs" may be sufficient to move these artificially-produced fogs from the parks and drift them about from place to place; but they will not disperse them altogether. A second source of fog is sometimes supposed to be the ring of hills round London, which lies low in the Thames Valley. The colder air on these hills rolls down in the morning into the saucer in which London lies, and mingling with the warmer, drier air of the town, produces a condensation amounting to fog. A similar phenomenon was observable in the winter of 1898-1899, when, on Christmas Eve, the wind, which had been blowing from the dry and cold east, suddenly backed to the south-west. The mingling of the two currents of air produced a thick fog, which lasted some hours before it was dispersed by the growing strength of the warm south-westerly current. The kind of fog thus described is, or can become, the very worst kind—that characterised by Charles Dickens as the "London particular"—and the stiller the air the longer it lasts, becoming thicker and blacker each day with the accumulating amount of smoke from London's million chimneys. In this case, as the Clerk of the Weather remarked in a recent paper, "the refuse which we thrust up our chimneys simply descends upon our heads and into our houses." There is another kind of fog which Dr. W. N. Shaw has compared to steam rising from water and condensing into a cloud at some distance above the water, leaving a certain number of feet comparatively clear of fog between the surface and the cloud. This is what we call an overhead fog; when it is so dark that the lamps have to be lighted, but when the air is not very thick at the level of the streets or the tops of the houses. Lastly, there is the fog which is almost comparable to the falling of a slight rain, and which Dr. Shaw believes to be, in a sense, identical with that phenomenon, but which is prevented from developing into rain by other meteorological conditions.

None of these fogs would be of very great disturbance to London—though fog is never welcome either in towns or in the clean country—if London did not add to its discomfort by shooting its coal refuse into the air, by this means not only making the fog intolerable, but aiding its formation by providing sooty particles on which globules of moisture can seize. The remedy for the plague of fog lies not with science, for no mechanical contrivances, however elaborate, could blow London clear of fog, but in the first place with the householder. It is the householder's grate and not the factory chimney's flue which is primarily responsible for the real smoke nuisance of London; though, as there are 14,500 factories in London, we cannot suppose them altogether innocent of blame. They contribute, perhaps, 2,000,000 tons of air fouled with smoke to London's atmosphere each day. The householder's contribution is larger. There are 600,000 houses in London, each of which we may suppose to keep two chimneys going in the month of December. Each chimney uses and defiles 10,000 cubic feet of air per hour. On these assumptions every house delivers about 8½ tons of smoky air a day into its neighbourhood. Altogether, therefore, London is charged with about 7,500,000 tons of smoky air a day. In a fog, this falls back on London. Sir W. Thiselton Dyer put the matter in another way. After a week of fog in 1891, he found upon the greenhouses at Kew—a comparatively-favoured atmospheric position for London—a deposit of tarry matter at the rate of six tons to the square mile. The actual weight of solid soot, which gives colour and body to the smoke—and the fog—is a very uncertain quantity. It may, in the worst cases, amount to nearly 3 per cent. of the coal consumed, and the houses of London probably get rid of 300 tons of solid refuse every day by throwing it up the chimney. There are other injurious products of consumption with it; but that is a fair estimate of the soot alone.

What can be done to remove this plague of smoke? Not only is the method by which the coal is burnt wasteful, but a bad fog is costly to London in many ways. The cost for additional gas alone amounts in London to £5,000 a day. The manager of the London General Omnibus Company told the writer that a bad fog lessened the receipts of their omnibuses by about £900 to £1,000 a day; and when all other costs are considered, a day's fog may be reasonably estimated to cost £30,000. It is, therefore, worth the while of Londoners to begin to think whether they might not systematise the removal of smoke from their town as they have already systematised the removal of sewage—the cost of removing which amounts to about £600 a day. If the householder could be persuaded to warm his house and do his cooking with gas fires; and if the gas were conveyed to London, as Sir Oliver Lodge suggested, from the coalfields where it might be produced, then the problem would be solved. But in the present state of systems of ventilation, which are mostly bad, the householder is not likely to give up his "open grate." It has, at any rate, the advantage of being one of the best means of ventilation which most rooms possess. Dr. Shaw has suggested another plan, which is to lead the flues of blocks of private houses into one "smoke chamber," where the soot-laden air might be treated by some process which would make the sooty particles coagulate. This is a sound proposition, and we cannot help believing that if anything is ever done by municipal effort, it will take this direction; though, probably, we shall have to wait until London is wound up to action by a few years of bad fog. Then, at any rate, the proposition may be considered by the London boroughs. We despair of anything being done at present, and one of the reasons for inaction may be ascribed to the curious immunity from fog which London has enjoyed during the winters of the last eleven years. Between the years 1870-1880, the winters were productive of 20 fogs a year on an average, and this average would have been much less but for the terrible winter of 1879-80, the Christmas of the "frozen fog," when some of the coldest temperatures of the century were experienced. In that winter there were 43 days of fog. But in the next decade the average leapt up to 30 days each winter, and in the year 1890-91, a record was established of 50 days of fog. It seemed, then, as if the winter fogs were steadily increasing with London's growing size and growing smoke. But to every meteorologist's surprise, the number of foggy days began to diminish steadily during the decade 1891-1901, and, so far from maintaining the rising average of the previous ten years, fell below the average of the previous twenty years. The figures have included a record for the lowest number of foggy days in any one winter. Mr. Brodie, of the Meteorological Office, attributes this surprising diminution in the number of fogs to the increasing use of gas stoves. It has also been attributed to the number of dry summers in the closing years of the nineteenth century. But this much is certain, London smoke is not growing less to any perceptible extent. Through the winter, St. Paul's cannot be seen from the Victoria Tower at Westminster, and London still loses half its sunlight from the smoke bank. In our opinion, the diminution in the number of fogs is only temporary, and they will return under appropriate meteorological conditions.

Colour Vision.

A series of scientific experiments which were made three years ago on the sensibility of the organs of sight and smell among primitive races seemed to indicate that these races had no clear distinction between blue and black. The investigations were made among the less visited islands of the Pacific where the natives had been very little touched by civilising influences, and many interesting results were obtained—among them the notable fact that though the average of keenness of eyesight among these primitive races was better than that among races whose eyesight is gradually deteriorating under the effects of artificial light, and (especially) of reading, yet, that abnormally good vision is no higher among these islanders than, for instance, among the picked artillerists of the German Navy. But the fact on which we wish to dwell at this moment was that one already mentioned—the natives' inability to distinguish between the colours of the violet end of the spectrum and black. It was pointed out at the time that among the aboriginal races of Australia, the same word was often used to denote the colours of blue and black, and the opinion was hazarded that among the earliest decorators of Egyptian and even Hellenic art the use of blue was uncommon, and was not understood—a fact to be attributed to the insensibility of the human eye in those days to minute differences. Dr. F. W. Edridge Green, who has spent a good many years in investigating the susceptibility of the eye to colour, has lately declared that primitive man could not distinguish colours at all; and that his ability to do so was only acquired with the development of a colour sense, which was as distinct from the mere perceptions of light and shade as good hearing is distinct from the possession of a musical ear. In the first instance, the eye learnt the distinction between the extreme colours—red and violet—which differ greatly in wave length. The other colours all appeared greyish. Then green would stand out in the grey field, later yellow, and finally blue and orange. Conversely, deafness began with insensibility to very high and very low notes. Dr. Edridge Green also comments on a curious form of trichromic colour blindness which now exists, and in which the subject is aware of only three colours, such as red, green, and violet, and talks of red-green when he wishes to indicate yellow.

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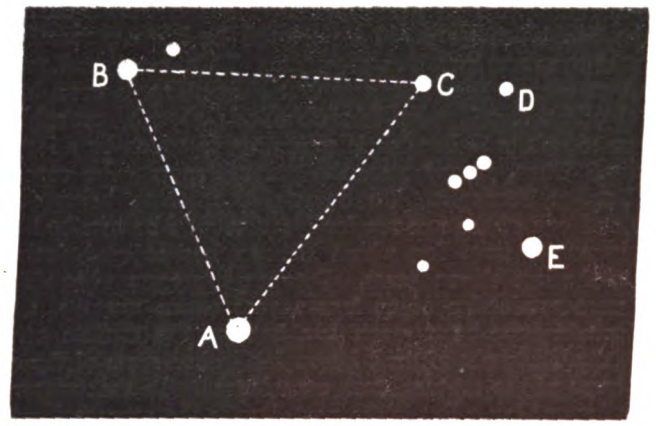
REVIEWS OF BOOKS.

ASTRONOMY.

"*Astronomy Without a Telescope*," by E. Walter Maunder ("Knowledge" office), 5s. Though at first one may wonder what there is to fill a book such as this, describing only what can be seen by the naked eye, it is surprising what a large amount of most interesting matter there is to learn in connection with the subject. Nearly half the book is devoted to the constellations, which, naturally, form the chief topic for discussion. The origin of the constellations, so ancient and so obscure, is gone into at some length. The locality where they were first recognized and named seems undoubtedly to have been in Asia Minor and Armenia. The original 48 were all visible from this point, the animals, &c., represented were known in these parts, and ancient tablets point to their having been known here for many ages. It seems fairly certain, too, that they were



mapped out at one time and in one place. Each of the principal constellations is described in turn, and how its position in the heavens is to be found. Some very clear diagrams, of which we reproduce a specimen, show the relative positions of the stars. The second section of the book is devoted to the sun and his apparent movement, the planets, and the moon; whilst the third treats of meteors, the Zodiacal light, the milky way, and the structure of comets. Here, too, is described the total solar eclipse, "sky effects," which refer rather to our atmosphere though affected by the sun, and variable and coloured stars. It is not usually known that no less than 400 variable stars have now been determined. This book has a peculiar characteristic, unusual with most books on astronomy, that all that one reads may be confirmed by strolling out into the midnight air on a fine night.

PHYSICS.

Waves and Ripples in Water, Air, and Æther, by Professor J. A. Fleming (Society for Promoting Christian Knowledge), embodies a course of Christmas lectures delivered at the Royal Institution, which, though by time-honoured custom supposed to be addressed to a "juvenile audience," appeal equally, so the author points out, to those who are young in spirit as well as to those who are young in years. It is an interesting subject this, extending from those phenomena of nature which are so familiar to our sight as waves on the sea and ripples in a pond caused by a stone thrown in, to those most abstruse and little-understood mysteries of Hertzian and electric waves in æther. Travellers who tell tales may be disappointed to learn that carefully-measured ocean waves have seldom been found to exceed 40 ft. in height; but another fact recorded, still less known, is that waves may travel from 30 to 40 miles an hour. But facts of a more practical nature are gone into later on, when the waves caused by a ship passing through the water are discussed. In the chapters on air waves, such interesting subjects as the disturbance of the atmosphere by the eruption of Krakatoa and the distance to which the sound of the guns fired at the funeral of Queen Victoria were heard are described. But among many other most fascinating examples of

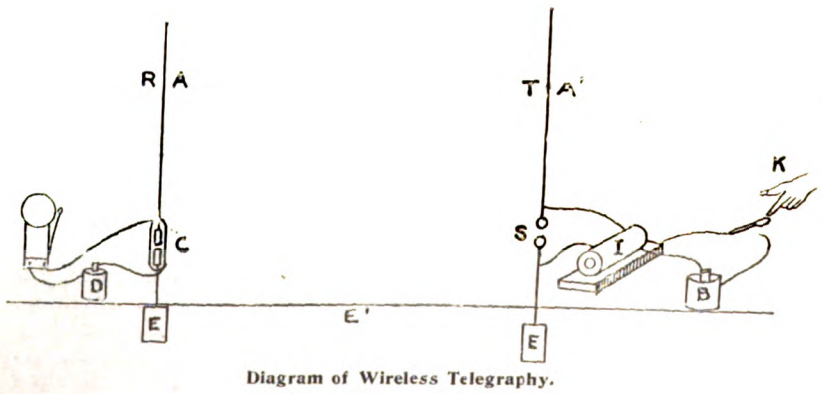
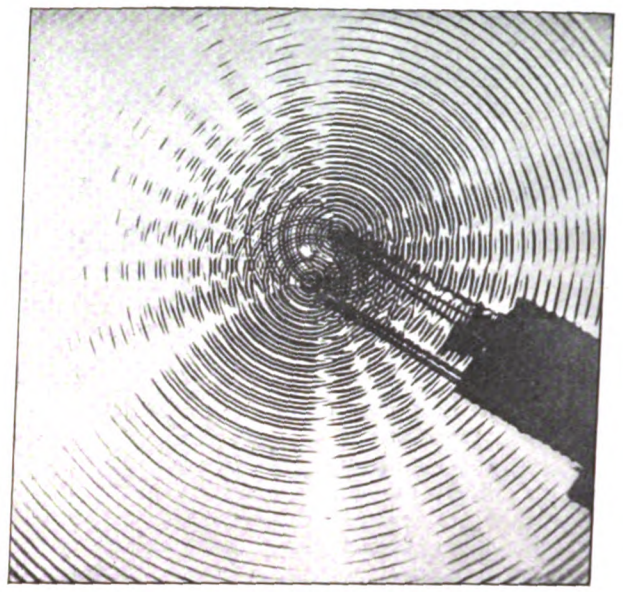


Diagram of Wireless Telegraphy.
From "Waves and Ripples."

air disturbances we look in vain for M. Marey's recent experiments in smoke-laden tubes. The vibrations of air in sound naturally come in for consideration, especially as regards the action of organ pipes. When we get to the chapter on electric oscillations and waves in æther, we find ourselves entering on a new land, and piloted by one of the most trusty of guides. A curious, realistic comparison is made to reveal to our denser minds the relative vibrations of waves of water, air, and æther respectively. If a splash could be made on the English coast sufficiently great to travel across the Atlantic, it would take something like 100 hours before its influence was noticed in America. If at the same moment tremendous sound report were made, this, travelling at about 700 miles an hour, would get across in four hours. If an electric spark caused an æther wave to start its vibrations, the same distance would be spanned in the sixtieth part of a second! This most fascinating book contains several good illustrations and a number of simple explanatory diagrams, of which some specimens are here reproduced.



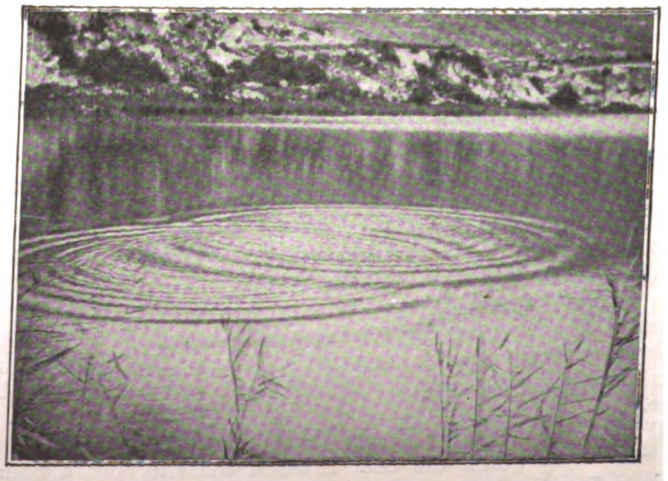
Invisible Ripples on a Mercury Surface.
From "Waves and Ripples."

MEDICINE.

How to Acquire and Strengthen Will-Power, by Richard J. Ebbard (The Modern Medical Publishing Co.). This book advocates in the strongest terms the efficacy of Suggestion in the treatment of maladies of a nervous nature; and, indeed, at the end of the Preface, boldly states that "every sufferer from nervous debility may now become his own physician; his fate lies in his own hands." The author, in his first chapter, advises, and wisely advises, an invalid who is anxious to get well to skip Part I. of the book. For the average individual, whether hale or ill, the advice is most excellent; for, though remarkably well written, and, indeed, most skilfully drawn, this part of the book will prove somewhat unintelligible to the lay reader. It wants the trained medical mind to grasp some of the facts put forward. Coming to Part II., the first chaper is devoted to "Diet for Neurasthenia," and here our first exception must be taken. What is this "tonic tea" so strongly advised by the author? Has it indeed the power to relieve the dyspeptic? Can it actually add to our blood forming powers, and is it actually a fact that, in addition to its other virtues, it possesses the property of removing the refuse products of our bodies? If this is so, then, indeed, this twentieth century is most fortunate! But the would be patient must be careful to read this particular chapter for himself, for there he will find that this all-powerful "tea" should be consumed daily for long periods, even after perfect convalescence. At 2s. a packet and 2d. postage the bill might very well reach respectable proportions, so much so that it is a possible matter for consideration whether advice and treatment from one trained to give it might not prove cheaper, if not better, in the end. And now for the cures which Suggestion will accomplish. It requires some amount of patience to read through the formulæ to be used in cases of insomnia, nightmare, and drowsiness, and however valuable the employment of Suggestion may be, one cannot help harking back to the old question, this "tonic tea" again. Of what use can it be in each one of these maladies? If it be an aid to sleep in insomnia, then how can it help the case of the lethargic, and how quieten the nerves of the victim of nightmare? Truly it is a wonderful fluid! Again, what is its value to the man who snores, and who breathes through his mouth? Does the author really believe that Suggestion, even when backed up by "tonic tea," can overcome a defect which is contrary to nature, and which, far from owing its origin to lack of nerve, is directly due to nasal and pharyngeal obstruction? We pass over the other maladies, and end by giving our readers a little homely advice. Read the book if you can, and will, but do not pin your faith too absolutely to Suggestion, nor to its coadjutor "tonic tea."

HISTORY.

"*The Rise of the Experimental Method in Oxford*," being the Ninth Boyle lecture, by Prof. Clifford Allbutt, M.D., F.R.S. (Henry Frowde), 1s., in other words, a brief history of the Progress of Science in Oxford, cannot but be an interesting brochure to the man of science or to the historian. To explain more clearly what the title implies, we may quote that "Roger Bacon proclaimed, what even Aristotle did not comprehend, that casual experiments are but curious incidents; and that knowledge consists, not in accumulation of curious incidents, &c., &c., but in detecting by the *Experimental Method* the series in which they occur." Most instructive it is to read the varying successes of the men who developed gradually the modern school of learning.



Interlacing Ripples.
From "Waves and Ripples."

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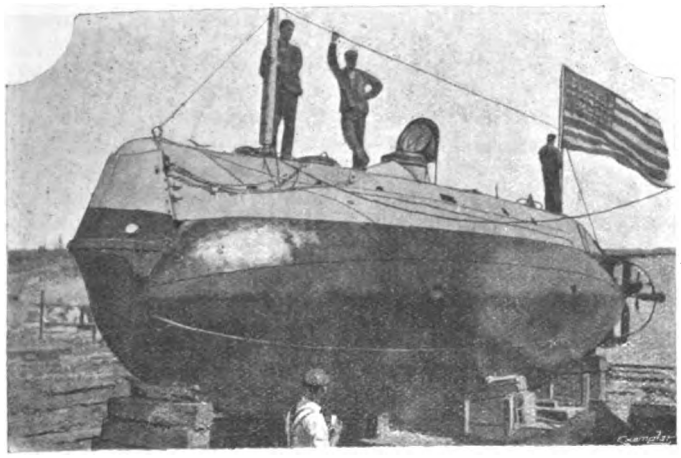
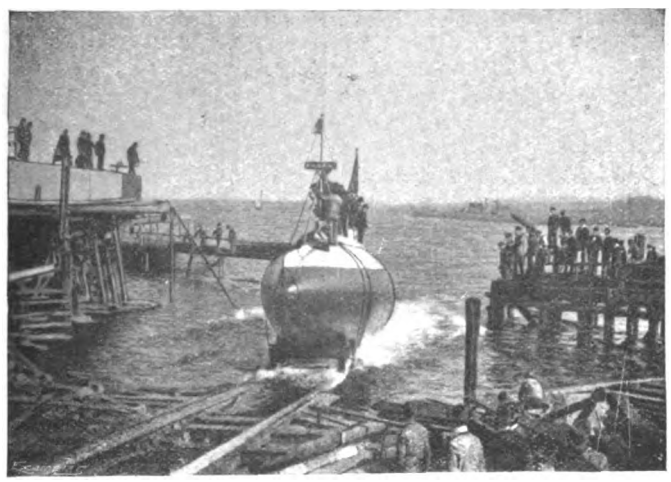
NAVAL.

"*Submarine Warfare*," by Herbert C. Fyfe (Grant Richards), 7s. 6d., with introductions by Admiral Sir E. Fremantle and by Sir Edward Reed, has the great advantage of being practically the only book in the English language devoted to this subject. It is, however, like most books nowadays, essentially popular, in other words, superficial. But it has to be borne in mind that the subject is one on which it would be extremely difficult, if not impossible, to procure detailed



A Holland Submarine.
From "Submarine Warfare."

information. Indeed, the author has to be congratulated on the amount of information he is able to give with reference to the submarine boats belonging to the French and other foreign navies. The illustrations, too, are plentiful and representative. There is a long chapter on the "Morality of Submarine (and it might be added, *other*) Warfare," in which are some good arguments for those to study who consider underwater attack underhand. The "Mechanism of the Sub-



Launch of a Submarine.
From "Submarine Warfare."

marine" gives a very good general idea of the different methods of propelling, steering, and other actions. After discussing the various modes of utilizing these vessels in action, a complete history of the invention is given. Altogether, it may be said that the book undoubtedly fills a hitherto vacant place on the bookshelf, and should be most useful to all who are in any way interested in this somewhat novel subject.

AERONAUTICS.

"*Travels in Space*," by E. Seton Valentine and F. L. Tomlinson (Hurst and Blackett), 10s. 6d., with an introduction by Sir Hiram Maxim. This book, though well got up, well illustrated, and even well written, would, we should have thought, hardly be of the kind for which there is any great opening. It is not sufficiently deep and detailed for the student of Aeronautics, and yet covering too much ground to be able to interest the general reader. It is very comprehensive, giving a complete history of balloons and flying machines from the earliest times to the present day. There are few events of importance in this line that are not chronicled. It is not padded out, as is so often the case, with sensational and unreliable accounts of balloon adventure. And yet each event, each invention is hurried past after a cursory glance at it. There is that mixing up, so often inseparable from works of this sort, of theoretical designs and actual machines. Thus, in describing Mr. Phillips's invention, which was actually propelled by a steam engine and made many trials, only some half-dozen lines are devoted to it, and the illustration (in quite another part of the book) is nothing like the apparatus actually constructed. The arrangement of the book leaves something to be desired, since the chapters have no headings, so that it is difficult to find one's way about it. The events are presumably arranged more or less in chronological order, but the dates are not always strictly correct. Nevertheless, this is quite the best book on the subject that has been published in England during the last thirty years, and, though a formidable rival may be expected in Mr. Bacon's book, which is just about to be issued, it stands alone as a good, readable work on modern aeronautics.

ENGINEERING.

"*Designing Ironwork—Second series Pt. III., Cisterns and Tanks*," by Henry Adams, M.I.C.E., M.I.M.E., &c. The subject of the designing of cisterns may not, at first sight, appear to be one of any widespread interest. But, as the author remarks in his preface, the bibliography of this particular handicraft is not extensive, and we may take it that this little brochure is the sole representative as far as England is concerned. The matter is one of some importance too, for pure water is nowadays looked upon as very essential to the well-being of the people, and badly constructed cisterns and tanks may be responsible for many ills. Wood, lead, galvanised iron, copper, slate, and porcelain are the materials most usually employed, and not only are each of them briefly treated of in this guide to the designing of ironwork, but most useful formulæ and information regarding the quantity of water required, rainfall, pressure of water, size and thickness of pipes, and other matters are gone into. Details of the sizes and thicknesses of plates, stiffenings, joints, flanges, and bolts are fully described and illustrated by a clearly drawn plate. A useful addition is a descriptive account of a number of actual failures of large tanks. The work is one which should be in the hands of all architects and builders.

BOTANY.

We have received two pamphlets on "*The Chrysanthemum: Its History and Development*," and on "*The Economic Properties of Agave Americana*," both by Mr. J. W. Wilson, M.A., F.R.H.S. Those who wish to know about the national flower of Japan, the mysterious but doubtful existence of the blue chrysanthemum, or the many and varied uses to which the so-called American aloe can be put, will find much well-put information in these pages.

A Second Edition of Messrs. Alexander and Thomson's *Elementary Applied Mechanics* is just published by Messrs. Macmillan, the two volumes of the first edition being now combined in one, and important additional matter being introduced.

Messrs. Macmillan and Co. publish *Mineralogy: An Introduction to the Scientific Study of Metals*, by Professor Henry A. Miers. The work falls into two parts, of which the first deals with the properties of minerals, while Part II. gives a description of the more important mineral species. It will be seen that all systematic accounts of the occurrence, distribution and origin of minerals is set aside for separate treatment, so as to secure greater clearness. The species described in Part II. are limited to those which the student can find in all museums, and can in many cases collect for himself.

Recent Patents.

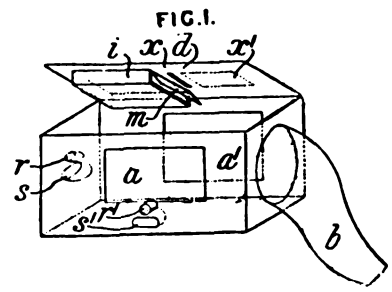
Selected from the Illd. Official Journal.

10,524. Photography. PAGE, S. E., 28, New Bridge Street, London.—(*Grenier Art Co.: 31, West 33rd Street, New York, U.S.A.*) May 21.

Printing.—Fabrics, paper, and other materials are prepared for the reception of the sensitizing-material for printing by impregnating with a solution of Irish moss, citric acid, and ammonium chloride, and then drying. 120 grammes of Irish moss are gradually heated to boiling in 32 litres of water; 16 litres of the extract are strained, and poured on to 160 grammes of citric acid, to which is added 40 grammes of ammonium chloride. Silk is impregnated by immersing it for a few minutes in a flat sheet in the solution, and then drying. The invention is for use in the production of tapestries, portraits, and decorative designs on fabrics.

10,547. Photography. OCHS, K., 4, Neumarkt, Worms, Germany. May 22.

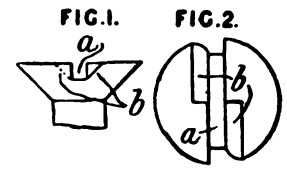
FIG.1.



Dark Rooms.—Relates to a portable dark box for developing and fixing plates and films and other dark-room operations. The box shown in perspective in Fig. 1 has panes of non-actinic glass a, a^1 for the admission of non-actinic light, and a sleeve b at one end for the admission of one hand to manipulate the plate, &c., inside the box. The manipulation is assisted by the fingers of the other hand, which are inserted from the outside into the finger stalls r, s. For films, the stalls r^1, s^1 are mounted directly under one of the windows a. On the underside of the hinged lid d of the box is a receptacle i with a light-tight lid m for holding plates or films or dark slides, when it is necessary to open the main box. Developing, fixing, and washing dishes are placed in the bottom of the dark box. Prints on bromide and like papers may be made by admitting light through a slit x, or through a yellow glass window x^1.

12,488. Wood-screws. RANDALL, G. I., 5, Terrell Street, St. James, and VALENTINE, P.O., 33, Gordon Road, Clifton, both in Bristol. June 29.

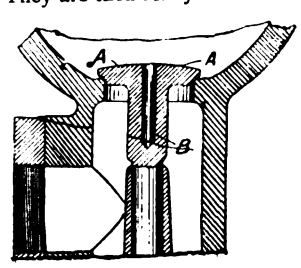
FIG.1. FIG.2.



The slot a has bevelled parts at b, so that the screw can be inserted, but not removed, as the screwdriver slips on the parts b.

13,300. Secondary Batteries. NODON, A., 97, Rue Saint-Lazare, Paris. June 29. [Date applied for under Sec. 103 of Patents, &c., Act, 1883, December 1, A.D. 1900.]

Relates to the manufacture of electrodes for secondary batteries, and is characterized by the fact that silicate of lead is an essential constituent of the active material. The invention is applicable more especially to the positive plates or electrodes. The active material is prepared by mixing red lead or litharge with a concentrated solution of sodium or potassium silicate, and kneading the material into a paste, which is applied to the lead grid by a spatula or brush. The plates are exposed to the air for one day, and are then immersed in a solution of alkaline silicate. After drying, the plates are immersed in a weak solution of sulphuric acid for some days, and are finally washed with water. They are then ready for the usual forming process.



14,794. Gas, Oil, and like Engines. JACOBS, B. J., Parrett Iron Works, Martock, Somersetshire. July 20.

Igniting.—One or more holes B in the exhaust valve A imprison some of the hot products of combustion, which, together with the heated sides of the hole, ignite the next compressed charge.

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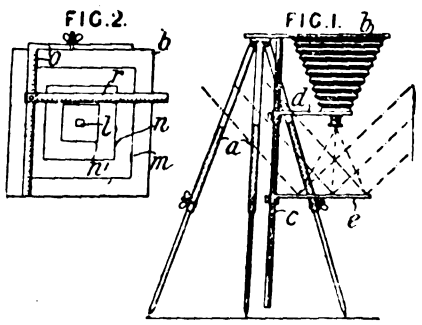
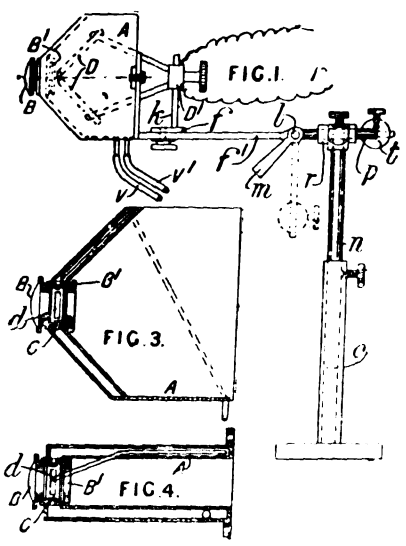
14,510. Photography. DREYFUS, L., 73¹, Kaiserstrasse, Frankfort a/M. Germany. July 16.

Cameras; enlarging; lighting-arrangements; camera supports.—Relates to a method of taking photographs in which the axis of the camera is vertical and the objects are supported on a horizontal table. The back of the camera is a horizontal table *b* fixed to the top of a stand *a*. From this table a vertical rod C projects vertically downward, and carries the bracket *d* which supports the front of the camera, and the table *e* on which the object to be photographed is placed. The attachments *d* and *e* can be adjusted up or down on the rod C. The slide containing the photographic plate is laid upon the table *b*, and its position may be adjusted by graduated arms *o* and *r*, Fig. 2, so as to bring any specified part of the plate opposite the exposure aperture *l*. Screens *n*, *n*¹, *m* may be used to change the size of the aperture. In a modification, the camera is supported above the top of the stand; or it may be supported horizontally by the same attachment. In the enlarging-camera there is an additional bellows to exclude side light from the negative. Light is projected through the negative by a reflector placed beneath it.



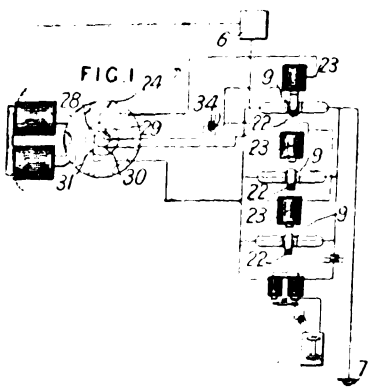
14,511. Electric Light, Treating Diseases by. MARSHALL, A. W., and WOODS, M. W., both of 2, Gray's Inn Road, London. July 16.

Relates to an electric light appliance for treating skin diseases. An electric lamp, such as an arc lamp D¹ of any suitable form, has its electrodes D opposite the lens or opening B in the casing A. The walls of the casing are double, and a tube or barrel C is fixed in them into which the front and back lenses B, B¹ are screwed. Packing-rings are used to make the lens joints water-tight. Openings *d* are formed in the barrel C and in the lens tubes to permit of the passage of water to and from the space between the walls of the casing A, and water is circulated in this space by inlet and outlet pipes V, V¹. The lamp D¹ is adjustable on a post *k* on a base *f* adjustable along a slot in the arm *f*¹ which carries the casing A. The arm *f*¹ is pivoted at *l* on a rod *f*, and is clamped in the required position by a nut *m*. The weight of the casing, &c., is balanced by an arm and weight *t*. The rod *f* passes through a block *r* pivoted on the upper end of a post *n* adjustable vertically in a socket *o*.



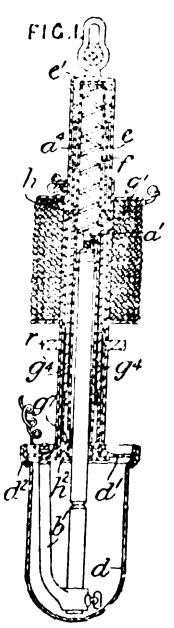
14,919. Wireless Telegraphy. SHOEMAKER, H., and GEHRING, G. P., both of 137, South Fifth Street, Philadelphia, Pennsylvania, U.S.A. July 22.

Relates to a system of wireless telegraphy in which at the receiving-station a number of coherers 9 are arranged in parallel between aerial conductor 6 and earth 7. The relay circuit also includes the coherers in parallel. Each coherer is surrounded by a loose magnetic ring 22, capable of being attracted by its decohering magnet 23. The magnets are in circuit with a battery 34 and three brushes 29, 30, 31, contact with each of which is made once in each revolution of the phonic wheel 24 by an arm 28 connected to the other pole of the battery.



14,963. Electric Lamps. HEANY, J. A., 904, Quarry Street, Philadelphia, Pennsylvania, U.S.A. July 23.

Arc Lamps.—An enclosed-arc clutch lamp is constructed as shown. Two concentric tubes, E, F, are connected and closed at the top by a plug E¹ provided with a suspending-loop, and are connected at the bottom by a ring H² and to a disc D¹, on which a globe D is secured by a coupling-ring D²; the disc D¹ carries an insulated lower carbon-holder B¹. The outer tube E carries a series solenoid G¹, and one or more magnetizable rings R, which retard the magnetic action of the solenoid on its movable core. The core consists of two tapered semicircular pieces G⁴, hinged together at their lower ends, so that their upper ends can move apart in the space between the tubes when they are magnetized, or when they come in contact with a bevelled ring H fixed between the tubes. The half cores carry non-magnetizable jaws G⁷, which pass through slots in the inner tube F to grip the upper carbon, but are withdrawn therefrom by contact with a bevelled surface on the lower ring H², when in their lowest position. The upper carbon slides through the ring H², and is inserted in a socket A¹, which slides in the inner tube and is connected electrically therewith by a flexible conductor A⁴; the socket A¹ is grooved to engage a vertical guiding-bead, pressed in the inner tube.



The Science of Illusion.

MYSTERY NO. 2.—SOLUTION OF THE MAGIC WRITING.

THIS trick is dependent on the mechanism of the frame. The apparently plain white canvas consists of a sheet of transparent paper, to give a smooth, even surface. To the back of this is pasted a sheet of paper perforated with a design similar to a stencil plate; behind this again a long sheet of paper is drawn, being rolled on rollers contained in the top and bottom of the frame, and actuated by clockwork or other mechanism. Black markings are made on this rolled paper, so arranged as to come behind the perforations in the requisite order, so that the black will first show on the left edge of the design, and gradually spread across the whole picture, and may then vary in colour and become fainter. The accompanying figures will make this clear. Fig. 1 shows a design which should be cut out and pasted on the back of a sheet of tracing paper. Fig. 2 shows the strip of paper which should be placed behind and drawn downwards behind the perforation.

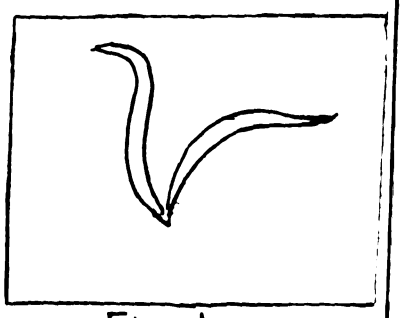


Fig. 1

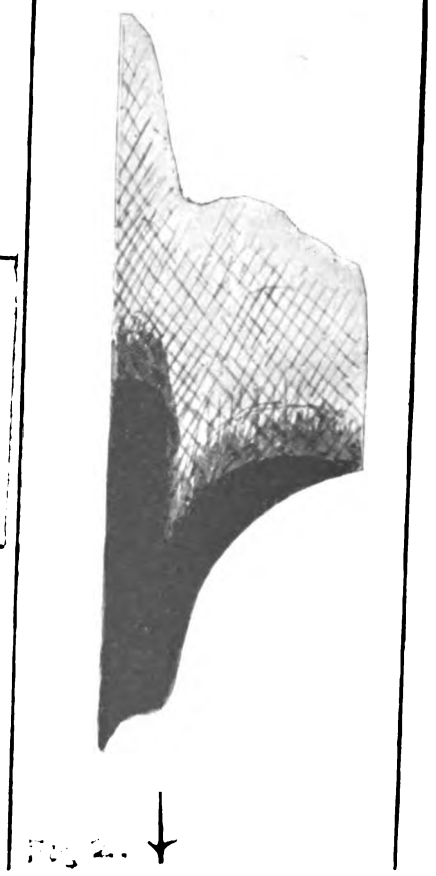


Fig. 2.

Mystery No. 3.—Materialization.

ON the rise of the curtain a practically bare stage is presented to view. The drop scene behind merely consists of a dark curtain, resting on the floor, and a carpet is spread over the stage. Any members of the audience may examine the stage to be sure there is no trap door or aperture in the curtain. A large urn (but not sufficiently large to contain a human body) is now brought on to the centre of the stage, and a fire kindled in it. Smoke begins to rise, and with accompaniment of slow music and the incantations of the showman, gradually the outline of a female figure clothed in white is discovered amid the smoke. The figure becomes more and more distinct, until the lady appears fully materialized. She opens her eyes, moves her arms and head, and even sings; but gradually the smoke thickens again, the figure is less distinct, and finally fades from the view. Members of the audience may again examine the stage, and even investigate the mysterious urn, but they will probably not be much the wiser for so doing.

SUSSEX NATURAL GAS.

To the Editor of "THE ILLUSTRATED SCIENTIFIC NEWS."

DEAR SIR,—I have seen in your last issue the letter from Mr. Horace Allen, in which he states that 18 per cent. of oxygen would render the gas dangerous for domestic purposes. When I wrote to you on the 16th ult. I said that I believed the analysis to be correct, this being the only published analysis obtainable. I have now received the result of Professor H. B. Dixon's experiments, who tells me that he has carefully analysed the gas and checked his experiments and finds its constituents to be as follows:—

Methane	93.4
Ethane	3.0
Nitrogen	2.7
Carbon Monoxide	.9
	100.0

There can be no doubt that these figures are absolutely correct.

Yours faithfully,

Heathfield, November 11th. INVERNESS WATTS.

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Prize Competition.

ONE of the principal objects of this journal being to encourage and foster the introduction and propagation of new ideas, the proprietors have decided to offer a series of money prizes to those who, in their opinion, send in the best and most practical solution of certain problems which will be set each month.

The designs must be sent in within a fortnight of the publication of the problem, *accompanied by the coupon* cut from this paper. Marks will then be allotted by the judges, and the competitor gaining the greatest amount of marks each month will be awarded the monthly prize of ONE GUINEA. But in order to encourage clever inventors, and not merely reward those who may happen to hit upon a happy idea, a GRAND PRIZE OF **ONE HUNDRED POUNDS** will be awarded at the end of the year (*i.e.* after 12 problems have been set) to that inventor who shall have gained the greatest aggregate of marks during that period, provided he shall have gained at least *30 per cent. of the full marks* in at least six of the competitions (whether he has gained a monthly prize or not).

In the event of an equality of votes or other exceptional circumstances, the proprietor will decide on the fairest method of distribution.

The following rules must be strictly adhered to, and solutions sent in not in compliance with them will be disqualified.

1. The solutions sent in must be concise, yet fully descriptive of the idea intended. To comply with this they must not exceed 300 words, and not more than two simple diagrams should accompany it.
2. Solutions will be published as considered desirable by the editor.
3. Competitors may obtain patent rights for their ideas, but they must run all risk of the publication in this paper interfering with the obtaining of such rights.
4. The number of marks awarded to each solution will be published every month. Competitors may send in their designs under a fancy name for publication, but their true names and addresses must be inserted on the coupon, which, in the event of their winning a prize, will be published.
5. The same person may send in two or more solutions so long as a separate coupon accompanies each.
6. Novelty of design is not a *sina qua non* (since this would be extremely difficult to prove), but only the person sending a description with the coupon is entitled to reward.
7. It would add to the value if a statement be added to say if the design has been practically tried; but to corroborate this the inventor may be called upon to give a demonstration before receiving a prize.

Results of last month's Competition.

"AN AUTOGRAPHIC TELEGRAPH."

(Full marks 100).

L. R. CONNOR (**80**). At both stations a wheel revolves at uniform (slow) speed. At the transmitting end a strip of tinfoil, on which the message is written in non-conducting ink, is fastened around its circumference; and the line wire is connected electrically to this. The ends of a number of insulated wires arranged in a row touch this strip, so that each wire conducts the current when touching the tinfoil but ceases to conduct when the insulating ink is interposed. The other ends of these wires are arranged around the circumference of a second wheel (revolving rapidly) on which is a projection which engages each wire in turn. This projection, being connected with the battery and return wire, completes the circuit. The receiver consists of a similar apparatus, the secondary wheel conveying the current in turn to each wire as required. The surface of the recording wheel, being covered with a strip of chemically prepared paper, is darkened when the current passes from the point of the wire to the wheel and left blank when no current passes. Thus the message appears as white on a background of dots. *Though much would depend upon the detailed carrying out of it, this idea seems to embody a very practical solution of the problem.*

R. FENTON (**70**). Message is written with insulating ink on a metallic drum mounted on a screw axle similar to that of a phonograph rotated by clockwork. A fixed needle, connected with the line wire, completes the circuit while in contact with the metal, but breaks circuit in passing over ink. Receiver consists of a similarly rotated drum with paper placed round it. A pen is arranged which marks the paper whenever released by an electro-magnet. *This idea, though not new, is simple and practical, if slow.*

"HARMONICA" (**55**). A "comb" of fine wires passes over a metal surface with the message written in insulating ink. Each wire is connected with a magnet, which when in circuit holds down a steel reed, each reed having a different period of vibration. These reeds are arranged over a coil on a soft core attached to a permanent magnet. The receiver consists of a similar set of reeds, underneath which is a coil in connection with that at the transmitting end. When one of the wires of the transmitter passes over an insulation, its reed is released and starts vibrating and sets up a pulsating current in the coil, which being communicated to the distant coil causes the reed attuned to the one vibrating to vibrate. The reeds at the receiving station have wires attached to their fine ends, which are brought close together to form a comb, and pass above a strip of chemically prepared paper over a metal plate, which is marked whenever a current passes. *An ingenious idea, though we doubt whether in would answer practically.*

E. M. F. (**50**). Message written with "oily ink" on paper tape placed round drum and wetted with acidulated water. Cable of 8 or 10 wires is used; the ends of the wires formed a brush on the paper. At receiving end each wire wound round electro-magnet controlling pencil to dot similar paper tape. *Simple, but cable objectionable; think might do for short distances.*

"HARDSTAFF" (**45**). A coil of wire carrying a mirror is suspended between the poles of an electro-magnet. As the current varies the coil will be more deflected and a pencil of light reflected from the mirror more or less across a strip of sensitive paper moved by clockwork forwards and backwards (to form the loops). The message is written on paper which is pin-pricked and placed on rollers moved by clockwork. This passes over a thin wire, various lengths of which being included in the circuit give the variable resistance causing different magnitudes of deflection of the needle. A connection is made each time a pin-hole comes over the wire. To transmit a loop in the writing the paper must be made to work backwards. This is done by making a connection on the wire at a definite point of resistance so as to release an escapement in clockwork and reverse rollers.

C. BURRAGE (**35**) suggests a transmitting board provided with metal keys corresponding with the letters of the alphabet. On touching them with a rod the circuit is closed. Each key is connected with a resistance box, so that a different force of current is sent according to which key is touched. The receiver consists of a galvanometer, whose needle is deflected in proportion to the strength of the current. On the end of the needle a "powerful magnet" is attached. Small discs mounted on springs are arranged around the circumference of the galvanometer, each corresponding to a given letter. On the middle being deflected the magnet attracts the disc opposite which it stops, and thereby closes the circuit of a rotary which operates a type-writing machine. *These two solutions, though ingenious, sound hardly practical, the strength of the current being apt to vary from many other causes.*

"SCIENCE" (**30**). Transmitter of kind of type writer with wires attached to each key. All wires "twisted together to make one wire." The receiver is a similar instrument so formed (presumably with electro-magnets) that "when the sender presses on a button, the same button will be pushed down at the other end" and typewritten. *This has the merit of simplicity, but the cable of a number of insulated wires and the typewriter are not very practical.*

BACILLIGRAPH (**25**). The telegraph cable comprises, say, 200 fine insulated wires. Message written with metallic pen on transmitting table, which consists of a non-conducting plate with 200 short wires vertically inlaid connected with "cable." The receiving ends of these wires actuate tiny electro-magnets, which depress the appropriate vertical wires or "ink-rods" in the receiver. *Cable of insulated wires objectionable, but if used, simpler transmitting and receiving apparatus applicable.*

"MOLTEN DIAMOND" (**20**). The transmitting station has a board with the letters of the alphabet, a wire connecting to each letter. All the wires are formed into a trunk and carried to the receiving station, where each wire is connected to an electro-magnet, which suspends a piece of steel above an easy-working typewriter. When the current is switched off any letter, the electro-magnet at the receiving station lets drop its armature on to the corresponding key of the typewriter. *This is not a very practical solution, requiring at least 26 wires, and a very strong current, as well as a typewriter, &c.*

FARANIGHT (**15**). Message written on plate of composition forming "a moderate conductor," with steel bars along side and end. The "pencil," with wires attached conveying the current, and mercury cup to vary current, contains lead for writing and two steel rods. The nearer it gets to bars the stronger the current passing through plate and pencil. Harmonic vibrator is in circuit, and the larger the vibration of reeds the more current will flow. Receiver is a steel plate with permanent and electro-magnets at the sides, which attract pencil with steel attachment. *Complicated and not likely to work in practice.*

R. WARREN (**10**). Receiver by electro-magnet makes marks of varying lengths on moving paper. An attendant, watching for given signal, moves marker back when necessary to start a fresh line close below that already made. *Clumsy method.*

"HALFPENNY" and P. J. JOHNSON (**5** each). *Impracticable.*

KASS (**50***). Transmitting and receiving drums revolve synchronously and have a relatively side motion to a recording or transmitting style. Message written on metal foil with insulating material and fastened round drum. Receiving pencil controlled by electro-magnet. To insure perfect synchronism of drums a thick line is drawn across the drum, by observing regularity of which the receiving operator can vary speed as desired. *Slow, and not very novel.*

[*KASS's solution was received strictly too late, but before the other marks were awarded. Should he, by including these marks, become entitled to a prize, an objection may be lodged and the case further considered.]

A correspondent (A. C. T.) asks whether we could not repeat the first competition so as to allow those who did not see it in time to score marks. We are afraid that such a course would hardly be fair. If done once there is no reason why it should not be done always, and competitors wait till the end of the year to send in all their solutions.

The monthly prize of one guinea has therefore been awarded to L. R. Connor, and a P. O. for that amount has been sent to

Mr. L. R. Connor,
4, Parade, North Finchley.

The subject for this month, December, will be—

"PROTRACTED ESCAPEMENT,"

that is to say, a method of controlling clockwork, so that a long period may elapse before the spring is run down. There are several well-known methods of accomplishing this, but they are mostly unsatisfactory in practice.

COUPON.

To the Proprietor, ILLUSTRATED SCIENTIFIC NEWS.

I herewith forward my idea for a solution of the problem on "Protracted Escapement," according to the conditions published in your paper, and I agree to comply with those conditions.

Full Name .....

Address .....

.....

Fancy Name for publication .....

Date .....

The advent of the New Year should be a good opportunity for commencing subscribing for the year's issue of "Illustrated Scientific News."

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Astronomical Calendar.

DECEMBER, 1902.

Month.	Day of Week.	SUN. Rises.	Sets.	Before Clock.	Right Ascension at Noon.	Apparent Declination (Sth.) at Noon.	HIGH WATER. LONDON BRIDGE. Morn.	After.	MOON. Rises Morning.	Sets Afternoon.	Right Ascension at Noon.	Declination at Noon.	Age at Noon.
		H. M	H. M.	M. S.	H. M. S.	° ′ ″	H. M.	H. M.	H. M.	H. M.	H. M S.	° ′ ″	D. H.
1	M	7 45	3 54	11 7	16 26 31	21 42 39	2 29	2 45	8 33	5 23	17 53 50	18 53 37s	1 10
2	Tu	7 46	3 53	10 45	16 30 50	21 52 3	3 1	3 19	9 19	6 15	18 23 47	18 28 36	2 10
3	W	7 47	3 53	10 21	16 35 9	22 1 2	3 37	3 54	9 59	7 9	19 18 8	17 15 27	3 10
4	Th	7 48	3 52	9 58	16 39 30	22 9 35	4 10	4 27	10 33	8 9	20 1 43	15 17 57	4 10
5	F	7 49	3 51	9 33	16 43 50	22 17 42	4 44	5 2	11 4	9 11	20 49 34	12 41 7	5 10
6	S	7 50	3 51	9 9	16 48 12	22 25 24	5 20	5 39	11 29	10 16	21 36 58	9 30 44	6 10
7	☽	7 51	3 51	8 43	16 52 34	22 32 39	6 1	6 25	aft.	11 21	22 24 7	5 53 7	7 10
8	M	7 53	3 51	8 17	16 56 56	22 39 28	6 50	7 15	0 18	mrn.	23 11 49	1 55 13s	8 10 ☾
9	Tu	7 54	3 50	7 51	17 1 19	22 45 50	7 42	8 14	0 42	0 30	0 0 43	2 14 47n	9 10
10	W	7 56	3 50	7 24	17 5 42	22 51 46	8 48	9 26	1 10	1 40	0 51 33	6 26 48	10 10
11	Th	7 57	3 50	6 57	17 10 6	22 57 14	10 0	10 33	1 39	2 53	1 45 5	10 27 30	11 10
12	F	7 58	3 50	6 29	17 14 30	23 2 15	11 6	11 36	2 12	4 8	2 41 51	14 0 45	12 10
13	S	7 59	3 49	6 2	17 18 55	23 6 48	...	0 4	2 55	5 25	3 41 59	16 47 31	13 10
14	☽	7 59	3 49	5 33	17 23 20	23 10 55	0 31	0 56	3 47	6 38	4 44 56	18 29 7	14 10
15	M	8 0	3 49	5 5	17 27 45	23 14 33	1 21	1 47	4 50	7 47	5 49 26	18 52 0	15 10 ○
16	Tu	8 1	3 49	4 36	17 32 10	23 17 43	2*12	2*36	6 1	8 43	6 53 44	17 52 16	16 10
17	W	8 2	3 50	4 7	17 36 36	23 20 26	3* 1	3*25	7 18	9 32	7 56 10	15 37 17	17 10
18	Th	8 3	3 50	3 37	17 41 2	23 22 41	3*50	4*16	8 36	10 10	8 55 42	12 23 2	18 10
19	F	8 4	3 50	3 8	17 45 28	23 24 27	4*41	5 5	9 52	10 44	9 52 2	8 29 5	19 10
20	S	8 4	3 51	2 38	17 49 54	23 25 45	5 29	5 55	11 4	11 12	10 45 26	4 14 20n	20 10
21	☽	8 5	3 52	2 8	17 54 20	23 26 35	6 20	6 45	mrn.	11 38	11 36 32	0 5 12s	21 10 ☽
22	M	8 5	3 52	1 39	17 58 47	23 26 57	7 12	7 40	0 18	aft.	12 26 6	4 16 42	22 10
23	Tu	8 6	3 52	1 9	18 3 13	23 26 51	8 9	8 40	1 26	0 27	13 14 50	8 10 0	23 10
24	W	8 6	3 52	0 39	18 7 40	23 26 16	9 16	9 53	2 32	0 54	14 8 21	11 36 46	24 10
25	Th	8 7	3 53	0 9	18 12 6	23 25 13	10 27	11 2	3 37	1 22	14 52 5	14 29 54	25 10
26	F	8 7	3 53	aft.	18 16 33	23 23 41	11 35	...	4 39	1 57	15 41 17	16 43 15	26 10
27	S	8 8	3 54	0 51	18 20 59	23 21 42	0 4	0 29	5 37	2 35	16 30 58	18 11 47	27 10
28	☽	8 8	3 55	1 21	18 25 26	23 19 14	0 52	1 14	6 30	3 19	17 20 58	18 52 3	28 10
29	M	8 8	3 56	1 50	18 29 52	23 16 18	1 35	1 54	7 17	4 8	18 10 57	18 42 33	29 10 ●
30	Tu	8 8	3 57	2 20	18 34 18	23 12 55	2 12	2 29	8 0	5 4	19 0 36	17 41 3	0 15
31	W	8 8	3 58	2 49	18 38 43	23 9 3	2 47	3 4	8 35	6 2	19 49 35	15 59 35s	1 15

Immunity in Children.

In a memorable Huxley Lecture which Dr. Welch delivered this year, he called attention to the properties which the human blood acquires to enable it to resist the attacks of the bacteria of disease; and he pointed out a possible reason why it is that children catch diseases and infections more easily than adults. The infant comes into the world with protective anti-bodies in its blood, smaller in amount and less energetic than those possessed by the healthy adult. It is an important function of the mother to transfer to the suckling through her milk immunizing bodies, and the infant's stomach has the capacity, which is afterwards lost, of absorbing these substances in an active state. The relative richness of the suckling's blood in protective anti-bodies or antidotes to disease, as contrasted with that of the artificially-fed infant, explains the greater freedom of the naturally suckled infant from infectious diseases. By anti-bodies, we understand those mysterious properties of the blood which destroy unfriendly bacteria, which neutralise the poisons they produce, or which render the bacteria unable to attack the blood of its host. These properties are called bactericidal if they kill the bacteria, or antitoxic if they neutralise its poisons, or agglutinative or hæmolytic if they hinder its activities. In some recent investigations by Doctors Halban and Landsteiner, fresh confirmation has been found of Dr. Welch's theory. They have found, by an examination of the blood of mothers and of newly-born children, that these properties of the blood are present in much greater quantity in the mother, and are much more energetic in action than is the case in the blood of the children.

Answers to Correspondents.

Colour of Shadows.—C. O. S. asks for an explanation of "the curious effect of colour in shadows cast by the moon in the presence of candle-light," pointing out that if, in bright moonlight, a candle be held near a white screen, and the hand interposed, the shadow cast by the moon is yellowish, while that cast by the candle is bluish. The explanation seems to us to be simple enough. Candlelight is yellowish, moonlight bluish. If both are thrown on a screen they neutralize one another. If the hand is so placed as to shade off the moonlight, the portion so shaded is illumined by the candle only, and is therefore yellowish. On the other hand, if the candlelight be screened off, the moonlit patch will appear bluish.

Diesel Engines.—Two correspondents ask for the address of the Company making these. The London Office is 171, Queen Victoria Street, E.C.

Peroxide of Sodium for Purifying Air.—Quite a number of correspondents have written to us with regard to this matter, referred to in our article last month. All that we are able to say at present is that this substance is well known and in frequent use, and should be obtainable from all wholesale chemists. It is in the form of a coarse, white powder—which should be spread on a plate, &c. The cost varies from 3s. 6d. to 7s. per pound according to quality. One correspondent, a clergyman, near Manchester, has tried the system of "ventilating" his rooms by this method with the most satisfactory results. For four days he lived in a small, gas-lit room with doors and windows kept closed, and at the end the air seemed perfectly sweet and fresh. Recognising the importance of this matter, we have decided to institute a series of experiments, the results of which we shall hope to publish next month. These will have regard to the chemical action set up, and the amount of the substance practically required to effect a beneficial result.

Lectures to be delivered in December.

AERONAUTICS.—Aeronautical Society (at Society of Arts, John Street, Adelphi), Dec. 4. 8 p.m.
The President: "Recent Aeronautical Progress."
Dr. W. N. Shaw: "The Contributions of Balloon Investigation to Meteorology."
Mr. J. Anderson: "The Kite Equipment of the Scottish Antarctic Expedition."

CHEMISTRY.—Society of Arts, John Street, Adelphi. Dec. 1, 8, and 15. 8 p.m. Cantor Lectures.
Professor Vivian B. Lewes: "The Future of Coal Gas and Allied Illuminants."

EDUCATION.—Society of Arts, John Street, Adelphi. Dec. 10. 8 p.m.
Mr. C. Brereton: "French Rural Education and its Lessons for England."

ELECTRICITY.—Institution of Electrical Engineers (at Inst. of Civil Engineers), Dec. 4. 8 p.m.
Mr. Swinburne: Inaugural Address.

ENGINEERING.—Society of Engineers (at Royal United Service Inst., Whitehall), Dec. 1. 7.30 p.m.
Mr. C. H. W. Biggs: "Depreciation of Plant and Works under Municipal and Company Management."

LOCOMOTION.—Royal Institution (Albemarle Street), Dec. 27 and 30. 3 p.m.
Professor Hele: "Steam Locomotion in Water and Air."

METALLURGY.—Society of Arts, John Street, Adelphi. Dec. 17. 8 p.m.
Mr. A. P. Head: "The South Russian Iron Industry."

NAVAL.—Royal United Service Institution, Whitehall. Dec. 3. 3 p.m.
Mr. H. N. Sullivan: "On the Use of Vertical Fire from the Sea Against Ships and Dockyards."
Royal United Service Institution. Dec. 10. 3 p.m.
Mr. Fred. T. Jane: "A Scheme for the Absolute Protection of Commerce in the next Naval War."

PHOTOGRAPHY.—Society of Arts, John Street, Adelphi. Dec. 3. 8 p.m.
Mr. A. Watkin: "Some Aspects of Photographic Development."

(Secretaries of all Scientific Societies are invited to send particulars of forthcoming papers, &c.)

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THE ILLUSTRATED

Scientific News.

A Monthly Journal devoted to Popular Science.

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All communications respecting advertisements to be addressed—

MESSRS. RATCLIFFE & DUNBAR, 1, LOMBARD COURT, E.C.

To Our Readers.

THE NEW YEAR.

AT the beginning of a New Year, arbitrary though that division of time may be in the life of a periodical, it is natural to review what has been done in the past year, and to attempt to forecast what will be done in the coming one. The ILLUSTRATED SCIENTIFIC NEWS is not yet of an age to have a great past of its own to look back upon; its outlook is concerned more nearly with the future, and in what it hopes to do in the future; but it is not wholly without the pleasures of retrospect. Many extremely kind and indulgent letters have been received from readers. The welcome from contemporaries has been hearty, sincere, and very gratifying to the conductors of this periodical. There have been few criticisms, fewer than we expected to receive, fewer indeed than we hoped to receive. Criticism is the seed of reform; and the ILLUSTRATED SCIENTIFIC NEWS has every hope and intention of becoming continually a more valuable and indispensable paper to all those who wish to keep in touch with the progress of the various sciences and scientific industries. Suggestions for new features, as well as criticism of those already existing will be welcomed, and will be carefully considered.

Although the ILLUSTRATED SCIENTIFIC NEWS has only been in existence a few months, it yet can look back upon a number of contributions to contemporary information on scientific matters, with a considerable degree of satisfaction. We propose to append a brief summary of the more important of these articles, less for purposes of calling attention to what has been done, than with the intention of providing those of our readers who may not have seen the earlier numbers, with references to them. Some of the articles, we venture to think, have been of an importance which may make their acquisition and preservation desirable. The first number began with an "Introduction" by the Editor, which set forth the aims and purposes of the periodical, aims and purposes both of which, we hope, have been hitherto fulfilled, and which we shall continue to keep in view.

Articles followed on RANGE-FINDERS, describing several new instruments for measuring distances, including those of Forbes, Gilette, and the "Simplex." LIQUID FUEL FOR SHIPS, showing how this subject is coming to the front, and is likely to be more heard of in the future. A NEW METHOD OF INFLATING BALLOONS by heated air. The PRESERVATION OF FLOWERS by drying them under a covering of fine sand. The PURIFICATION OF WATER by the addition of a small quantity of acid, preferably sodium bisulphate. A new SHALLOW-DRAUGHT STEAMER, by Yarrow, on an improved principle. NATURAL GAS IN SUSSEX, describing this extraordinary find, and giving views of the spot. PLOUGHING AND REAPING BY MOTOR, with the "Ivel" agricultural machine. The new GIRAFFES AT THE ZOO, described by Dr. Sclater, and the OCCULT TRANSMISSION OF NEWS, doubting the accuracy of many accounts of native "thought transference." A sketch from nature of the great COMET OF 1901 was reproduced. Our first portrait supplement represented SIR WILLIAM HUGGINS, the President of the Royal Society. This number contained as supplement a complete, if necessarily short, summary of the papers read before the British Association.

The second number opened with an interesting article by Prof. Turner, the Savilian Professor of Astronomy, on SCIENTIFIC ANECDOTES, which was followed by an account of the valuable new process of generating ACETYLENE without water, a description of the experiments of the Meteorological Committee with KITES, and articles by Mr. E. S. Bruce on VOLCANIC EMISSIONS and Major Baden-Powell on the DE BRADSKY AIRSHIP. An extremely interesting lecture on BECQUEREL RAYS by Prof. J. J. Thomson is reprinted, the new economical DIESEL ENGINES, the 4·7 GUNS, the EARTH'S ROTATION, proved by Foucault's pendulum, and NEW DETECTORS FOR WIRELESS TELEGRAPHY are described, as well as the method of AIR PURIFICATION by the simple exposure of peroxide of sodium, which latter article created a considerable amount of interest and elicited much correspondence from persons anxious to test or adopt the system. LORD KELVIN is the subject of the portrait supplement.

The December number commenced with an interesting account, by Sir Robert Ball, of "THE INVISIBLE UNIVERSE," descriptions of the Crewe system of ELECTRIC RAILWAY SIGNALS, extracting NITRATES BY ELECTRICITY from the air, LONDON FOGS, the SEGREGATION OF STEEL RAILS, and of that new wonder with such vast potentialities THERMIT. Some FACTS ABOUT OUR BRAINS are described by a leading authority, the OBSERVER OF EARTHQUAKES alluding to Prof. Milne's wonderful observations, and a full description of the NILE DAMS, by Mr. E. S. Grew, are given, the latter being illustrated by what we feel we may describe as an exceptionally fine photographic reproduction.

The REVIEWS OF BOOKS have appeared in each number, though it was only in the last one that they have been illustrated. It is hoped that this will greatly add to their value as giving a better idea of the nature of a book than can be conveyed by words alone. The column on RECENT PATENTS has elicited favourable comment, intended as it is to give an idea of the way inventions are trending. The series of examples of the SCIENCE OF ILLUSION also seem to have given satisfaction to many readers. At first it was a matter of some doubt as to whether such articles could be considered as suitable to our pages, but we believe from opinions which have been sent us that they do form a welcome addition which is looked upon as interesting and amusing. They form a valuable collection, since none of these mysteries have before been publicly explained. The PRIZE COMPETITION, we hope, is fulfilling its object of arousing interest in invention, though it was certainly hoped that more competitors would send in their solutions. The list of FORTHCOMING LECTURES arranged under the headings of subjects should be of convenience to those wishing to attend, and our new *résumé* of notable SCIENTIFIC ARTICLES in recent periodicals has only been commenced in this month's issue. It is hoped that this will also form a valuable feature.

We hope that during the coming year we shall be able to present a number of useful and important articles, many having been promised by some of the leading authorities of the day. We can only ask that our readers, if satisfied, will assist the progress of the paper by recommending it to their friends, and doing what they can to enlarge the circulation.

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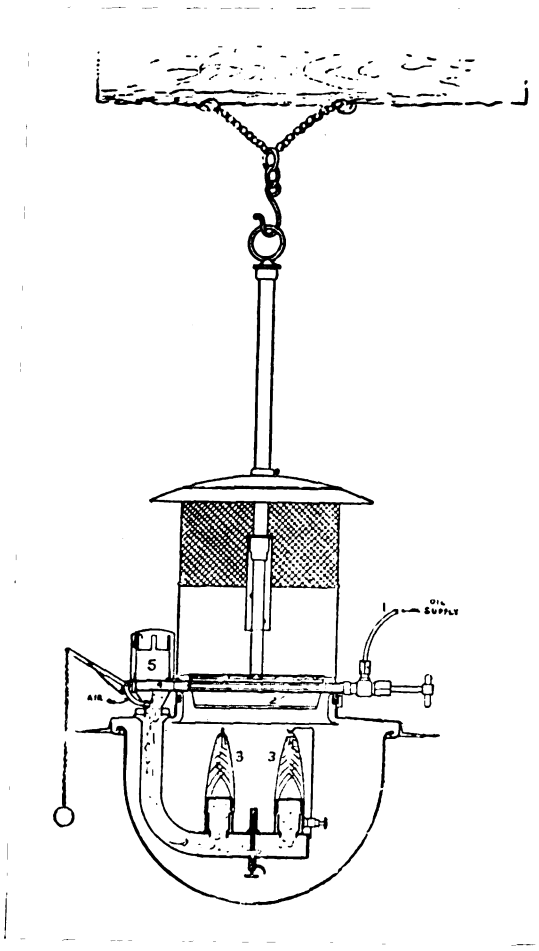
Incandescent Oil Lamps.

NUMEROUS and wonderful are the improvements brought out in recent years in methods of illumination.

The old gas system was improved by the introduction of the incandescent mantle. Acetylene gas followed, burning with as brilliant a light without the frail mantle. Electric lighting seemed to be well nigh perfection, but now we combine the oldest illuminant of all, oil, with a mantle, and obtain an exceedingly brilliant light at but a fraction of the cost. Several systems for accomplishing this have recently been introduced, all being very similar.



Section of Lamp.*

The general principle of these lamps is that the petroleum under air-pressure, is forced from its tank to the lamp, where the heat vaporizes the oil, and this gas, with a due admixture of air is conducted to the burner, which is surmounted by a mantle, similar to that used on gas lamps.

These have three great advantages over either gas or electricity, in that they are portable, and that no large plant is necessary for the generation. They also claim to be very much less costly to burn. And thirdly, that the light is more brilliant, pleasant, and penetrative. It is also steady and not liable to interruption in the supply.

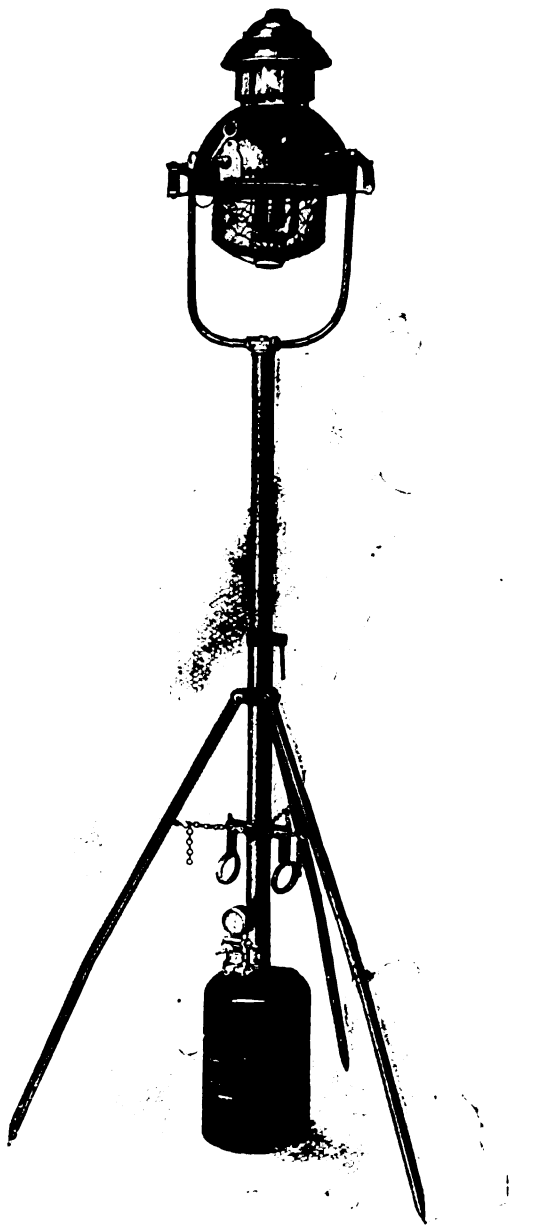
The Kitson light, which appears to be the best of its kind, has a cylindrical steel tank of oil, containing from 5 to 40 gallons, which may be placed in the base of the lamp, or at some distance off. This is filled about $\frac{1}{8}$ full of oil, and, by means of a hand-pump attached, the remaining space is filled with air at a pressure of 50 lbs. to the sq. in., a gauge in the top indicating when sufficient pressure is attained. At the side of the tank is a gauge by means of which the quantity of oil in it can be seen.

The oil from the tank is conveyed in a small tube $\frac{1}{8}$th inch diameter; that is to say, only about the size of ordinary electric light wires, but tested to withstand a pressure of 300 lbs. to the lamp. The tubing may ramify to any number of lamps, and may be carried as far as 1,000 ft. The oil is thus conveyed into the vaporizing tube, which runs horizontally above the burners, and is heated by them, whence it issues, in the form of gas, to the mixing tube, and being then mixed with a due proportion of air, is carried to the burners, of which there are usually two or more. So the cycle is complete, and the actual incandescent flame is brighter than that of gas burnt in a similar way. As carbonization is liable to result in the small hole through which the oil gas issues, a needle-like wire runs through the centre of the vaporizing tube so arranged that by moving a handle (which may be done by a cord), the needle point pushes into the hole and clears it of residue.

The lamps are usually of 1,000-candle power.

It can easily be understood that for the illumination of any place, such as a factory, etc., this system is both cheap and convenient, since no central plant need be erected, and no elaborate system of wires or pipes has to be laid. It is especially to be borne in mind that the tearing up of public thoroughfares is thus obviated.

As for the economy of the system, we need only quote a few figures given by an engineering company in Sunderland who have used nine 1,000-candle power lamps for four weeks. The average amount of oil consumed per week was 40 gallons, and the average number of hours run was 72. The oil cost 9½d. a gallon, the cost of mantles, glass, man's time, etc., was £2 10s. 9d. So that a total of £8 18s. 2½d. was the cost of 9,000-candle power for 290 hours, or four-fifths of a penny per lamp per hour. Similar figures are given



Portable Lamp.

by other consumers. The cost per 1,000 candles per hour is given as:—

Electric incandescent	12½d.
Electric arc	3½d.
Gas	12½d.
Gas, incandescent	3.2d.
Kitson	.8d.

Approximately the oil consumption by Kitson is $\frac{5}{8}$-pint per hour per 1,000-candle power. A paper is shortly to be read on this subject by Mr. Kitson at the Society of Arts.

The Greatest Flying Creature.

From Fossils to Flying Machines.

BY MAJOR BADEN-POWELL.

PROF. S. P. LANGLEY, the well-known Secretary of the Smithsonian Institute at Washington, has compiled a short but interesting pamphlet introducing a paper by Mr. F. A. Lucas, of the United States National Museum, bringing evidence on the important question of the greatest weight which can be lifted in the air by living animals.

It has sometimes been set forth as an argument against the probability of the introduction of a large flying-machine, that birds and other flying creatures appear to possess the facility of flight in the inverse order of their size. That is to say, that a gnat or fly is able to rise and progress through the air in any direction with apparently

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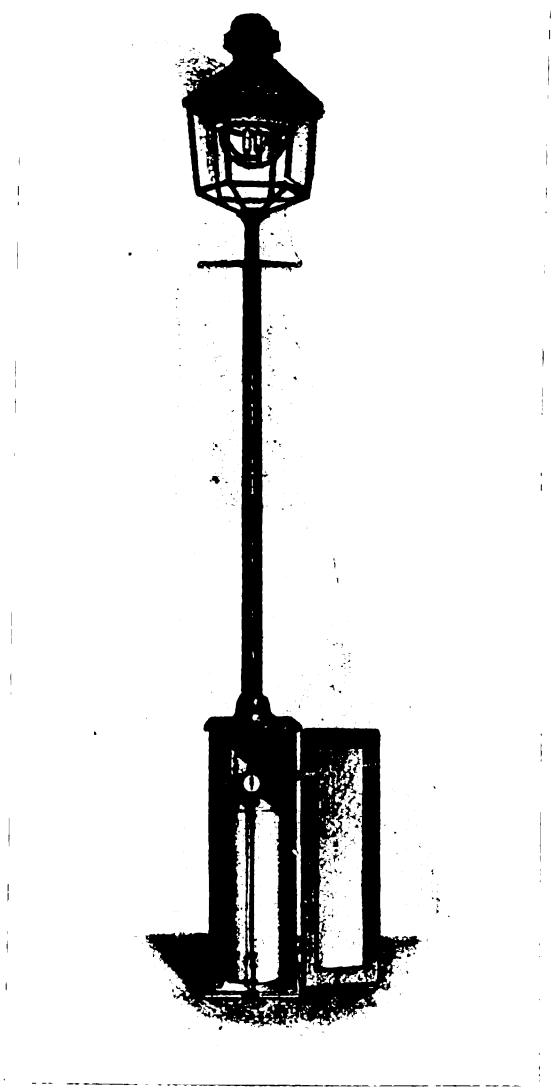


Lamp Post.

the greatest of ease. A large bird like a vulture or swan appears to make a supreme effort in flapping its huge wings, and is only able to launch itself into mid-air after a more or less prolonged run over land, or flapping of its feet over the surface of the water. And again, larger birds still, such as the ostrich and the cassowary, are not able to rise at all. Hence, it is argued, a man, together with such machinery as may be supposed capable of translating him through the air, would require a still greater effort, and in fact be quite incapable of flight.

But to refute such reasoning, the evidence of the geologist may be called in. Fossil remains have been found of various large animals which, without doubt, possessed the ability of flight. Professor Langley instances the pterodactyls, and gives an illustration of the skeleton of the *ornithostoma ingens*, the largest species of this strange reptile, alongside that of a condor. The skeleton of the wing of a bird does not give a true idea of its expanse since the long primary feathers extend some distance from the bone. But it is supposed that the pterodactyl was a featherless reptile with a wing somewhat similar to that of a bat, that is to say, consisting merely of a membrane stretched on the actual bones.

This fossil skeleton indicates a spread of wing of about twenty feet, but it may be noted that two specimens of pterodactyl have been found in England supposed to have a spread of wing of 25 feet. The wings of the condors, on the other hand, although sometimes said to attain a width of 15 feet, are not known for certain ever to much exceed 10 ft. 6 ins. The wings of an albatross may possibly slightly exceed this in length, but they are narrower.

No one animal, Mr. Lucas points out, combines all the best features of weight, power, and wing area, for those with the greatest expanse of wing are by no means the heaviest and strongest, while the most powerful birds are not those of longest sustained flight. The frigate bird is, perhaps, the most at home in the air, but he lacks carrying capacity, and sails by skill rather than by strength. Birds of prey, on the other hand, which can carry away a quarry of nearly their own weight, fly, when they do this, with laboured strokes of the wing and with an apparent expenditure of considerable power. Both the albatross and frigate bird have great extent of wing, though little width, and therefore area, and they also have a comparatively small amount of muscle, since they but seldom require to beat their wings. The heaviest bird is probably the trumpeter swan, attaining a weight of 28 lbs., though only having a spread of wing of eight feet. The minimum of wing area, both positively and comparatively, is reached in the humming birds.

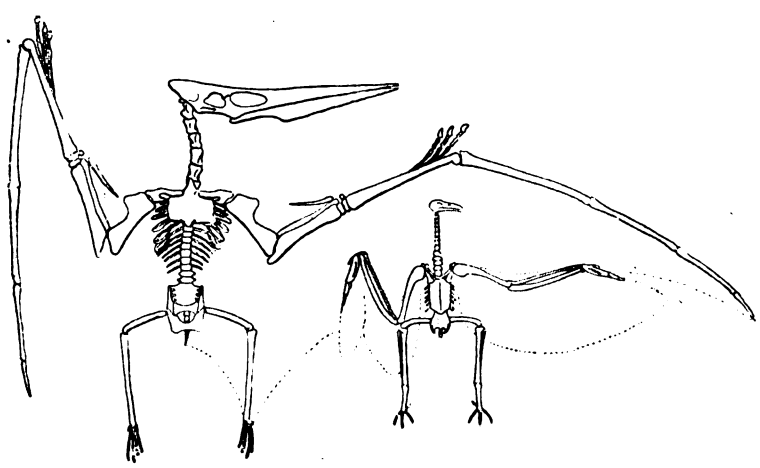
Much may be inferred from the fossil remains as to the characteristics of the ancient flying creatures. The shape of the beak, with the suggestion of the presence of a small pouch, like that found in cormorants, as well as fish-bones and scales having been found among the remains, would seem to imply that it lived on fish. From the long narrow shape of the wings, and from the comparatively small size of the breastbone, and therefore presumably, of the pectoral muscles, the *ornithostoma* doubtless sailed somewhat after the manner of the albatross, and without often flapping its wings. Another reason for supposing this is the great support given to the wing, as is the case with modern soaring birds, by the shape of the bones about the breast. That it was capable of long-sustained flight, is presumed from the fact that its bones are found under conditions indicating that it went far out to sea.

It is supposed that this strange creature was not very heavy for its size. The skeleton is small and the bones of exceedingly light build. Prof. Williston has said that one of the finger bones, 28 inches long and 2 inches in diameter, was no thicker than a cylinder of blotting paper. This authority places the weight at only 25 lbs.

But Prof. Langley takes us a step further than the comparison between what is probably the largest flying creature that the world has seen (though there are some who have reason for supposing that very much larger did exist), and the modern bird. He compares these with his model aerodrome, a machine actuated by a steam engine, which accomplished some really remarkable flights a few years ago. He makes out a table as follows:—

	Supporting area in sq. ft.	Weight in pounds.	Horse-power.
Flying machine	54	30	1.5
Pterodactyl	25	30	.036
Condor	9.85	17	.043
Turkey Buzzard	5.3	3	.015
Wild Goose	2.65	9	.026
Pigeon	.7	1	.012
Humming Bird	.026	.015	.001

Further commenting on these figures, Prof. Langley says that from the obvious mathematical law, that the area in bodies in general increases as the square of their dimensions, while their weight increases as the cube, it is an apparently plain inference that the larger the creature or machine the less the relative area of support may be. So that we soon reach a condition when we cannot imagine flight possible. But mechanical theory points to other conclusions, which open up a large subject for careful consideration.



Skeleton of the great Pterodactyl Ornithostoma compared with that of the Condor.

The Pterodactyl after a figure by Prof. S. W. Williston.

Artificial Shellac.

A FIRM has recently been established in Wiesbaden for the production of "Daumin," a substance having all the characteristics of shellac. The first quality, pure, clear, and easily soluble, costs 140 marks per 100 kilos.; the second quality, suitable for varnishes, costs 110 marks. Genuine shellac costs almost double these prices.

Electricity on Hard and Soft Surfaces.

M. HESEHUS has made some exhaustive experiments with metal plates and other bodies, showing their electrical characteristics. A polished surface is always positive relatively to one of the same substance unpolished. So also of two discs of wood, that which is cut parallel to the grain is always positive to one cut across it. If two plates of different metals are brought in contact, the softer metal will be positive, while with non-metallic substances are the more positive as their hardness is greater.

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Round Houses.

AN ECONOMICAL AND ADVANTAGEOUS MODE OF BUILDING.

ROUND houses, though not unknown even among ancient structures, and common to the huts of many native tribes, are hardly to be seen in everyday life in England. Yet such have occasionally been constructed, and with very good reason, for the advantages which their builders urge seem theoretically sound, and, though they may, perhaps, be somewhat overrated, form an interesting subject for enquiry. The following are some of the special qualities claimed as appertaining to edifices of this kind :—

1. We know, from our geometrical teachings, that the circumference of a circle is the shortest line enclosing a given area, therefore a circular wall will contain the least amount of material and involve the least amount of labour to construct, for a given internal space.

A Round House.

2. For the same reason such a building will have a smaller surface of outside wall, so that it should be warmer.

3. It is contended (though the point is challenged by some architects) that, in practical building, a plain wall, even though curved, is easier and cheaper to build than one containing many corners.

4. Such a shape is specially suitable in exposed situations, as the wind glides off without shaking the house so much. It also prevents snow from drifting against the walls.

5. The whole arrangement of the house for dwelling in is compact and convenient. Passages are reduced to a minimum, and a well-warmed central hall may be arranged.

6. The roof too, of a conical shape, is simpler to construct than one with ridges and angles.

7. Further, such details as the laying of electric-light wires, gas-pipes, bell wires, &c., are greatly simplified.

Let us take an instance: Suppose the round house to be 40 ft. across. The outer walls will then be 125 ft. in length, while the superficial area enclosed will be 1,256 sq. ft. Now take an ordinary shaped house such as that in fig. 2. This latter, if containing the same amount of room, will have walls 183 ft. long, or nearly half as much again. If the house, in both cases, be divided into a hall of 315 sq. ft. and six rooms averaging 157 sq. ft., the round house would have a central hall 20 ft. across, the remaining space being divided into six divisions (which may be varied as the dotted lines show). Each of these rooms would have three inner walls to one outer, while the hall would not have any of its wall exposed to the outer air.

In the other house shown each room would have at least two walls to the outside. It would require twelve corners to be carefully constructed, and a number of complicated ridges in the roof.

We are able to give a view of a house recently built on this plan in Scotland as a shooting lodge for Mr. Barber Starkey at Knock Shannock. It will be seen that the appearance is by no means ugly, embellished as it is with architectural additions, and it forms a most comfortable dwelling. This house, it may be noted, is two-storeyed, and the centre hall has a gallery round it giving access to the bedrooms. The conical roof is surmounted by the "lantern" which gives light to the hall. Kitchens, stables, and other out buildings are also built on the same pattern, and the whole is said to have cost considerably less than is usual for a house of its size.

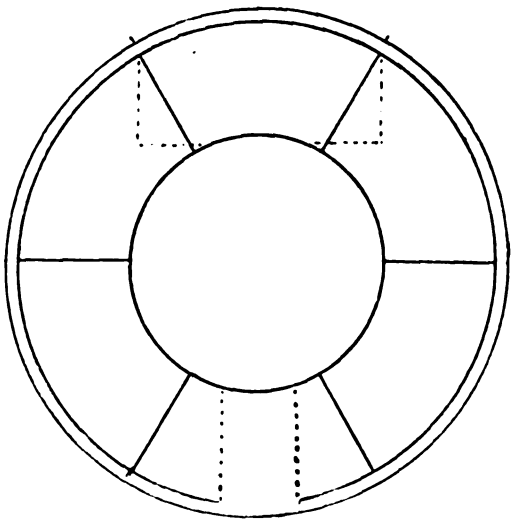

Fig. 1

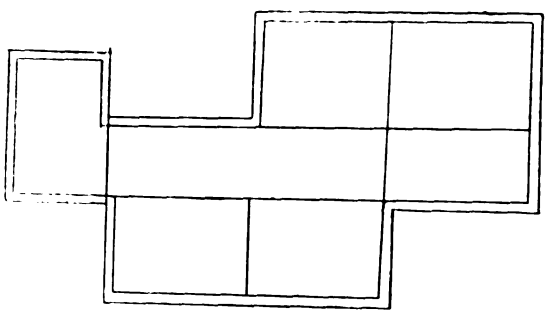

Fig. 2

Power from Air Currents.

NOVEL FORM OF ELECTRIC LIGHTING.

MANY attempts have been made to light trains electrically in England, France, and Germany; and this form of lighting has a great advantage over gas in that there is no danger of explosion as there is in the case of the compressed gas in cylinders. On the other hand there is the great objection that hitherto all forms of electric lighting on long distance trains have had to make demands on the locomotives for power. The power as absorbed may look small when compared with the total power absorbed by the engine, and it is undoubtedly so; but when, as often happens, the engine is working to its last ounce the difference counts. It is not the average road that tells the tale and strains the coal and water space and the steaming quality of the boilers, but the gradients which have to be mounted here and there, and for which the engines have to be carefully nursed. A locomotive dragging a heavy fast express up a long grade may very often be compared to a runner in the last strides of a quarter mile, and the extra demand of the electric motors is then felt as a decisive factor.

This objection does not appear to apply, however, to the new method of obtaining power which is the characteristic feature of the "Gullot" system of electrically lighting trains. This system, which is described in the *Engineering Times*, from which our illustration is taken, has been successfully applied on a small scale on a railway, and is to be now tried on express trains. As in the case of ordinary train electrical lighting, which takes power from the axles, the train is used to generate the electricity. Instead, however, of the power being taken from the axle, it is furnished by a rotary fan attached to the front of the locomotive, as shown in the illustration. The fan is located close to the boiler head, and presents a moving and cutting surface to the air pressure, causing the air to travel to the outer end of the fan's blades until discharged. No air pressure is massed on the flat surface of the boiler head, but the curved surfaces of the fan blades utilise the travelling air and thereby generate power. The fan cutting through the air revolves swiftly,

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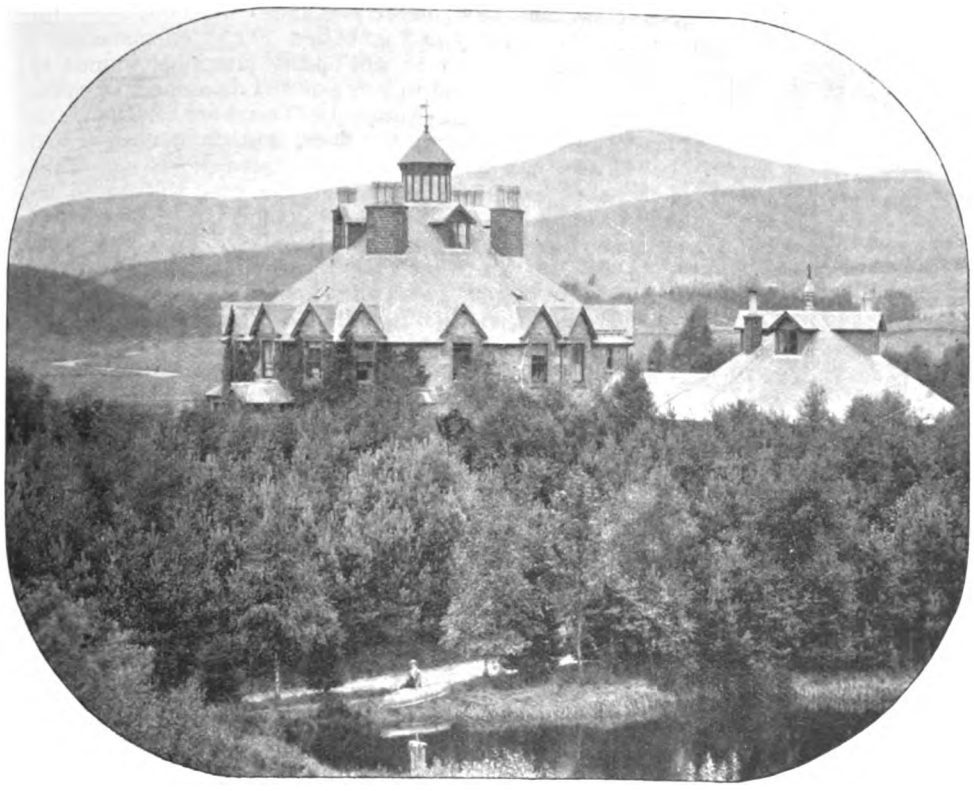
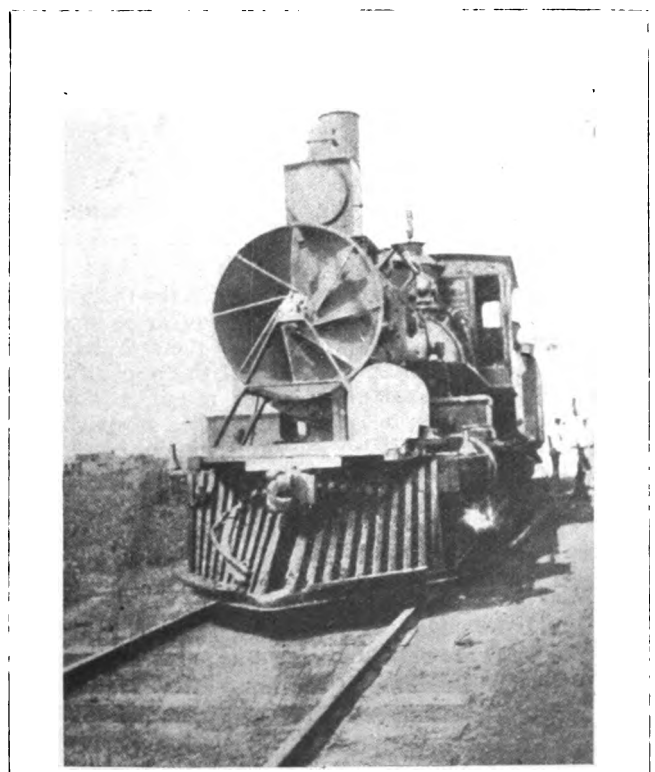


Knockshannock House.

and does not add to the resistance of the air nor retard the speed of the train. No gale of wind is required to cause the fan to operate; the ordinary pressure of the train moves it sufficiently to generate the electrical energy required to light any train and leave a large surplus for ventilating fans and other purposes. The apparatus so located does not obstruct the view of the engineer nor offer any objectionable complications.

The dynamo is located either on or under the pilot, and is direct-connected to the fan by a special device. A storage battery is located on the tender or underneath each car, and so equipped automatically with cut-outs as to properly govern the flow of current from dynamo to battery. It is evident that the cost of illumination will be only the expense of installing and maintaining this apparatus.

Recent tests on a train running forty-five miles per hour resulted in the development of 4·5 k.w. per hour, which amount of energy is sufficient to charge the storage battery so that it will illuminate a train of five cars seven hours per night and leave the battery with nearly its maximum charge, due to the continuous operation of the fan. On high-speed trains greater power and efficiency are obtainable.



Electrical Notes.

AN appeal was lately made, supported by the King and the Prime Minister, for the proper and sufficient endowment of King's College, London. Apart from the endowment of professorial chairs, money is required in order to bring the laboratories up to the standard of modern requirement. This is especially necessary in the Electrical Engineering and in the Mechanical Engineering Laboratories. For the *Engineering Laboratory* about £25,000 is required for additional buildings, a portion of which it is proposed to set apart for research. The additional equipment required includes a Willans, Belliss, Peache, or other high-speed engine, a Corliss engine, a Westinghouse or other direct-coupled gas engine, a Mond or Dowson gas plant, a Parsons or other rotary engine, a Galloway boiler, a Babcock or other large tube boiler, a Thornycroft or other Express boiler, a Green's economiser, a Worthington cooling tower, a compressed air-pumping plant, a Ledward or Korting ejector condenser, a Ledward evaporative condenser, a Pratt and Witney or other measuring machine, hydraulic accumulator tanks, &c. For the *Electrical Engineering Laboratory* about £50,000 is required to cover the cost of extensions, additional equipment, and such charges as are absolutely required for the successful working of the department. The additional equipment includes the following:—Steam boiler, steam and gas generators direct-coupled, storage battery, direct and alternate current motors, transformers, switchboards, resistance frames, measuring instruments, switches, synchronising apparatus, shafting, repairing apparatus, traction apparatus, balancers, boosters, &c.

COMING COMETS.

IN the coming year the returns of eight periodical comets fall due, though it is unlikely that more than two of three of them will be visible.

The following list is taken from the current number of *Knowledge*:—

Comet.	Periodic Time in Years.	Approximate Dates of Last Aphelion Passage.	Approximate Dates of Next Perihelion Passage.	Number of times previously observed.
(1) Temple-Swift	5·534	3 Mar., 1900	9 Dec., 1902	4
(2) Perrine ..	6·441	10 Feb., 1900	5 May, 1903	1
(3) Giacobini ..	6·549	3 Feb., 1900	15 May, 1903	1
(4) Spitaler ..	6·402	3 June, 1900	16 Aug., 1903	1
(5) Faye ..	7·566	1 Jan., 1900	13 Oct., 1903	8
(6) Winnecke ..	5·832	18 Feb., 1901	30 Dec., 1903	7
(7) Brooks ..	7·097	25 May, 1900	12 Dec., 1903	2
(8) D'Arrest ..	6·675	24 Sept., 1900	25 Jan., 1904	6

The first of these comets was discovered in 1869, and has been seen at intervals of eleven years. The two comets called Perrine and Giacobini were discovered in 1896; Perrine's comet will be invisible owing to its seeming proximity to the sun, but Giacobini's comet may be seen. Spitaler's comet was discovered in 1890, and has already returned once, though it was unobserved. Faye's comet was discovered as early as 1843, and its re-appearances have hitherto been made with great regularity, though it is feared that owing to a conjunction of circumstances, its record may this year be broken. The comet Winnecke was discovered by Pons in 1819, and that of D'Arrest in 1851. Brooks' comet may not impossibly be visible, though, in the present state of knowledge it cannot be predicted with certainity whether any comet will or will not be visible.

ELECTRIC COAL CUTTING.

ACCORDING to the figures published by the United States Bureau of Statistics the largest share of the coal production of the world, which has for many years rested with British coal fields, is now produced by the American fields. Last year the coal output of the world was 866,165,000 tons, of which the United States produced 34 per cent., Great Britain 28 per cent., and Germany 19·2 per cent. England's percentage is falling; Germany's is nearly stationary; that of the United States is rising. The rapid increase in the last-named country has been attributed largely to the use of electric coal cutters. The use of these cutters is, however, increasing fast in England. At a general meeting of the Midland Counties Institution of Engineers held at Nottingham, an interesting paper was read by Mr. W. E. Garforth on the application of coal-cutting machines to deep mining. In the discussion which followed, the question of the safety of electric motors in fiery pits was again to the fore. It was said by one speaker that a gassy mine was a source of danger, but that there was no greater risk in using a properly designed electric motor in such a mine than there was with the ordinary miner's safety lamp. In a gassy mine a fracture of the lamp would mean an explosion just in the same way as a fracture of the motor case would do. His opinion was that if there were a sufficiently great amount of gas to be ignited by a small spark from a motor, the pit was totally unfit to be worked at all.

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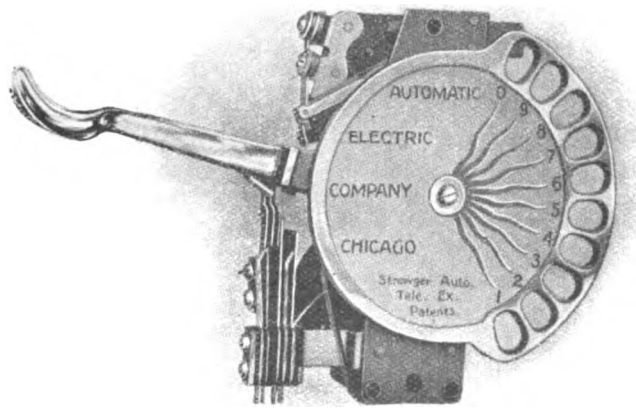
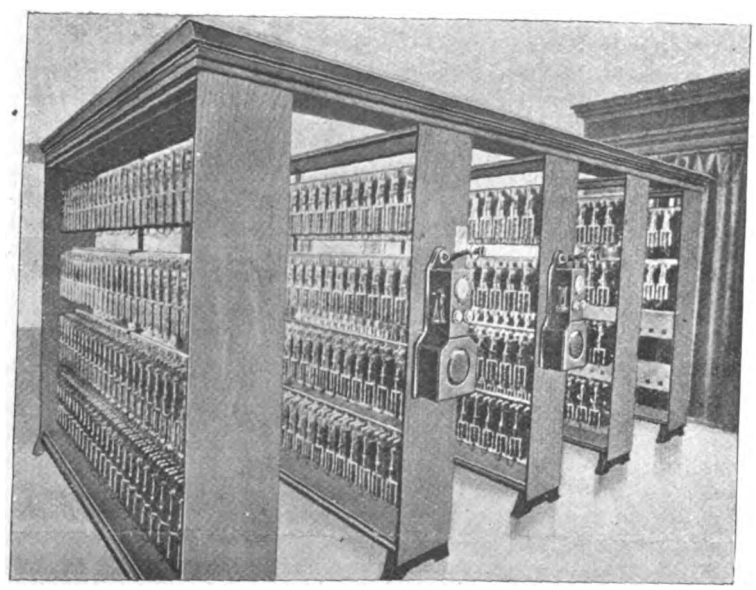
Automatic Telephone Exchange.

IN order to understand the Automatic Telephone Exchange which is to be described, it will be as well to briefly explain the operation of a telephone exchange in which the connections are made by human agency. Each subscriber to the exchange has now a pair of wires running from the nearest branch of the exchange system to his residence, or place of business. Each subscriber must also have some means of calling the attention of the exchange, and there



The Subscriber's Dial.

must be means of calling the attention of the subscriber wanted, and making connection between his line and the subscriber who wishes to communicate with him. In the early exchanges each subscriber's instrument had a magneto generator, and a bell responding to the currents generated. In the exchange were a number of small electromagnets, arranged to respond to the magneto currents sent out by the generators in subscribers' offices. Calling in the early exchanges was effected by a shutter fixed in front of the electromagnet connected to the subscriber's number, dropping and disclosing his number. The indicators, as the electromagnets with their shutters were called, were arranged in a rack, in front of which the "telephone girl" stood, and made connection between the subscriber and an attendant at a table, who ascertained the number he wanted, called the number, and the girl at the rack switched him through. This method has long given place to one occupying less space, and taking less time, and known as the "Common Battery" and "incandescent lamp" system. The chief Post Office Telephone Exchanges



The "Exchange."

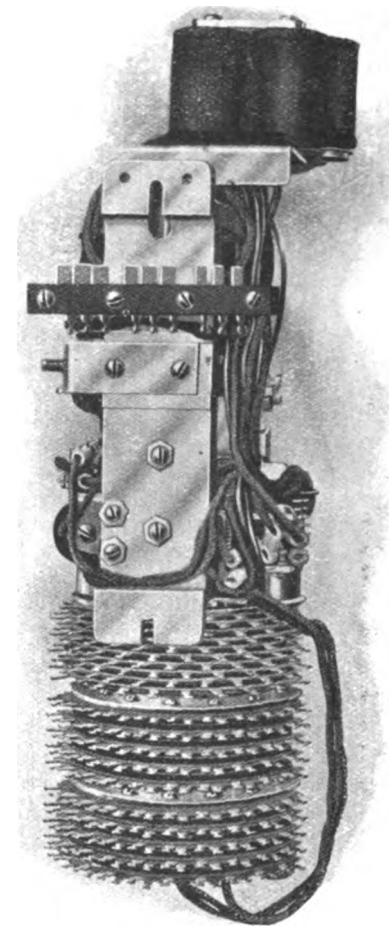
are fitted with it; and the National Telephone Company is using it in the South Kensington Exchange.

The Common Battery System.

The latest method has a number of very tiny incandescent electric lamps for the indicators, and the operators in each exchange deal at once with the whole of the switching required. Thus, a subscriber calls the exchange now by taking the telephone receiver off its hook, thereby sending a current to the exchange, which lights up one of the tiny lamps referred to, and calls the attention of the operator. Each operator has not only her own number of subscribers in front of her (she usually looks after 80), but she has the means of connecting to other subscribers, or to other exchanges in connection with hers, the switches, &c., being in front of her. The "telephone girl" has therefore to receive a call, to call up the subscriber wanted, to make connection with him, and to look out and disconnect when the conversation is finished. The Automatic Telephone Exchange is intended to do all that the operator does, and do it cheaper and better. It will be seen from what has been stated above, that as the use of telephone exchanges is increasing, the cost will go on increasing, unless something can be done to reduce it, to almost prohibitive figures. Already a good deal has been done, the latest being the adoption of what is known as the common battery system, in which the old time magneto generator is done away with, and the whole of the current required for "calling" is supplied from a power station at the exchange itself.

The Automatic Apparatus.

Stated shortly, the method adopted in the Automatic Telephone Exchange consists in the substitution of a series of electromagnets, in place of the operators and the indicators. When the operator knows the number of the subscriber required, she "selects" him from the number in front of her. She looks down the thousands, then down the hundreds in that thousand, then down the tens, then the units. The electromagnetic "Selector" does exactly what the human operator does. It first selects the particular thousand in which the subscriber's number occurs, then the particular hundred in that thousand, then the ten, and finally the unit. In the Automatic Telephone Exchange under consideration, however, the human operator is outdone in another particular. It goes without saying that if each subscriber had an operator to look after him entirely the work would be much better, provided that the operators worked as well as they do now. In the Automatic Telephone Exchange, each subscriber has his own operator, in the form of a "First Selector."



The Front View of the First Selector.

The Selectors.

The "selectors" are instruments in the care of the subscribers themselves; and by means of them the subscriber, instead of calling the number he requires to the exchange, signals it to the exchange. The subscriber's apparatus is very similar in appearance to the latest forms used with the ordinary exchange. In front of the apparatus, in the position usually occupied by the transmitter, will be noticed a dial finger plate in the illustrations. This has ten finger holes—0 to 9—and the holes are made to take the average finger. The dial plate moves round on its centre, and the subscriber, when he wishes to call another subscriber, places his finger in the number corresponding to the thousands in the number he wants to call, and moves the dial as far as it will go. A kind of hook will be noticed at the bottom of the dial plate, not connected with it, but attached to the body of the apparatus. As the finger in the hole in the dial plate moves round, it is stopped by the hook. The dial is then released, and at once moves back to its original position. The subscriber then does the same for the number representing the hundreds in the number he wants to call, and after releasing the dial, does the same for tens, and then for units. He then presses the button that is seen below the dial plate, holding the telephone receiver to his ear at the same time. If he hears a sharp click, he is through to his man; if he hears a buzzing his man is engaged, and he hangs his telephone up. The dial plate is fixed on the same central spindle as a contact wheel, which will be seen in the illustration of the interior of the subscriber's apparatus, and as the subscriber moves the plate round, he moves the wheel with it. When the dial plate is released, the contact wheel runs back under the impulse of the spring controlling it, making as many contacts in its return as the number of the thousands, hundreds, &c. Thus suppose he wants the number 5445. He first moves the dial to the figure 5. This signals the integer of the thousands to another instrument at the exchange. The frame 4 follows for the hundreds

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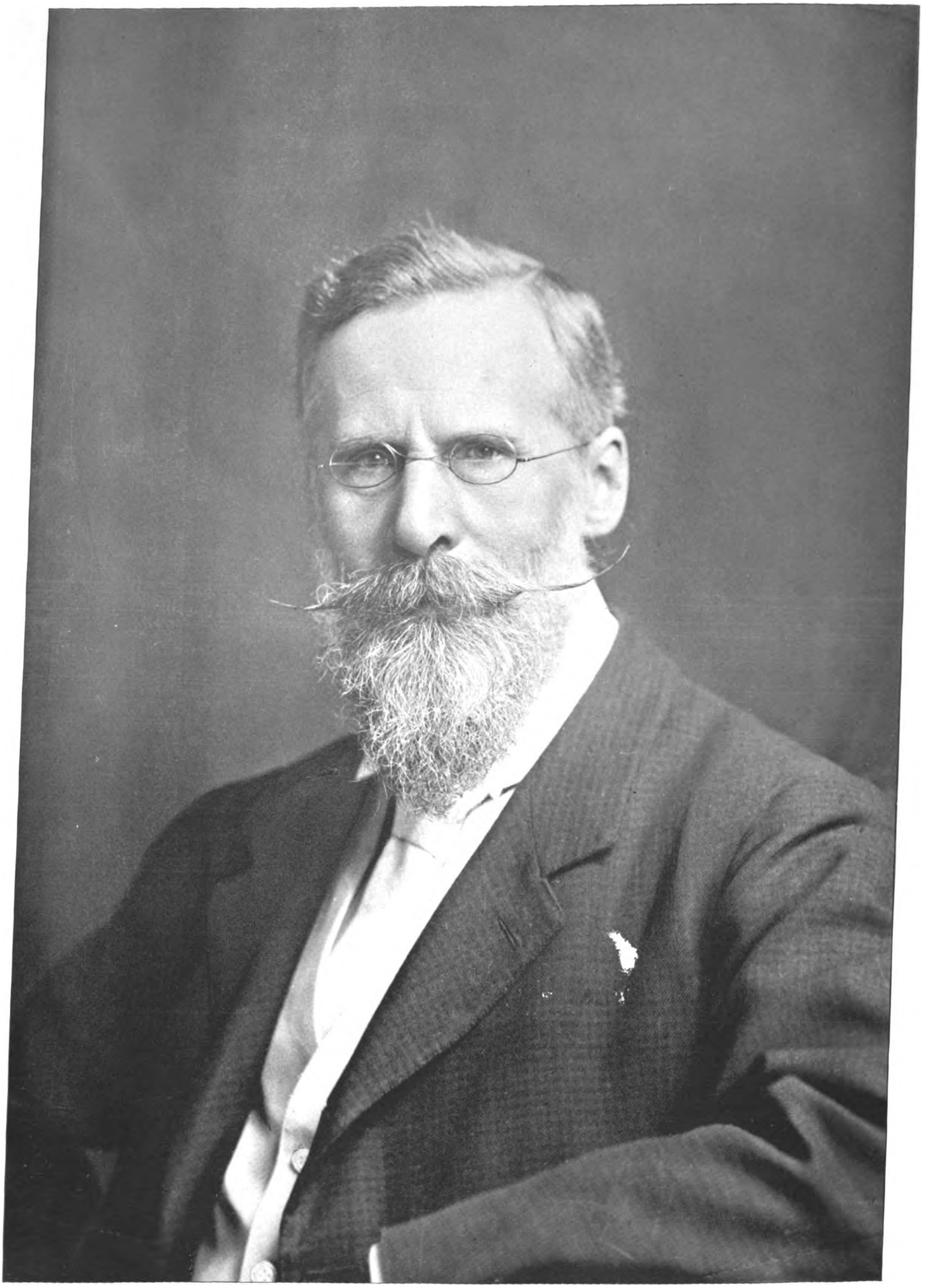

Elliott & Fry.]

SIR WILLIAM CROOKES, F.R.S.

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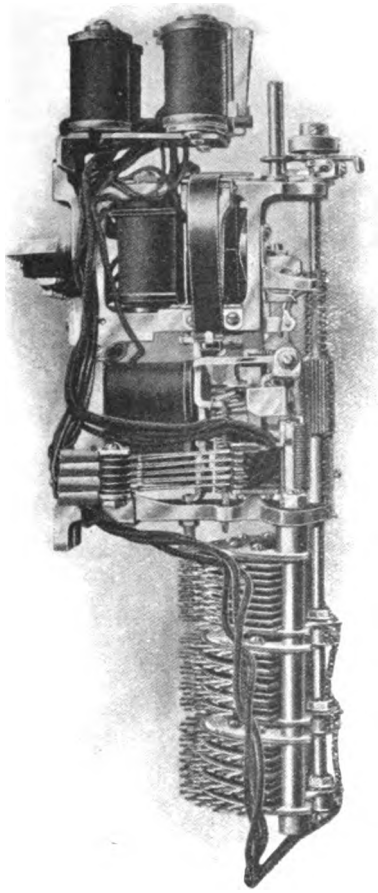
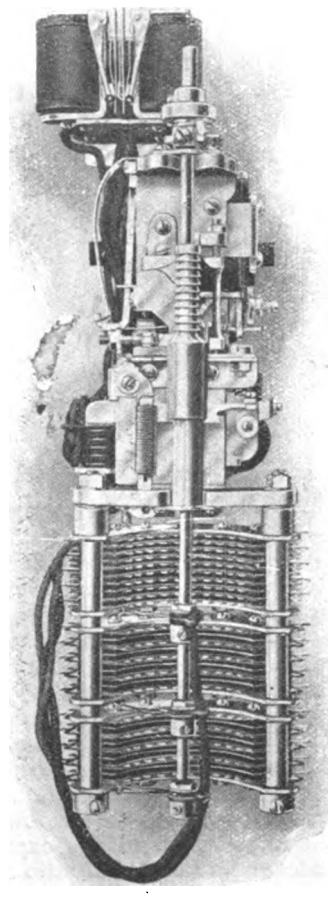
another 4 for the tens, and a 5 for the units. He has thus signalled the whole number 5445 to the exchange. The illustrations show a sort of "skeleton" of the "selector." There are banks of contacts in it arranged in semicircles; and on a plan not unlike that of type writers, and still more like that of certain kinds of type-setting machines, these revolve automatically. When the subscriber is moving the indicator of his dial they revolve in such a manner as to send currents along the wires to a "second selector" at the exchange. These currents pick out on the "second selector" at the exchange a number which is identical with that which the subscriber has picked out on his dial. Perhaps the "second selector" at the exchange—which is the individual instrument of the subscriber wanted—may be already blocked. That is to say, the subscriber wanted — No. 5445—may be engaged. In that case another device produces a buzzing sound in the first caller's telephone to indicate that No. 5445 is engaged. If No. 5445 is not engaged, the "second selector" at the exchange automatically calls him up in the same way that the "telephone girl" would signal him either by turning a handle, or pulling over a switch. The foregoing summary is a very brief, and a very inadequate one for describing a beautiful and ingenious apparatus, which is complicated by many devices of arms and triggers for making or breaking contacts.



The Second Selector, with Connections.

The System in Active Operation.

The system described above is in active operation in America, amongst other places at Fall River, Massachusetts, and at New Bedford, Massachusetts. Each of these exchanges is arranged for an ultimate capacity of 10,000 subscribers. The German Government have also made an official trial of the system, and are stated to be arranging for fitting up Government automatic telephone exchanges all over the German Empire. The apparatus, it will be understood, is applicable to small exchanges, such as are now common in large works, to town exchanges of all kinds, and for interconnection with the ordinary telephone exchanges. It is made by the Automatic Telephone Exchange Company, of Chicago, on the Strowger patents, and the address of the London agents who are exploiting it in this country is 61, Birkbeck Bank Buildings, Holborn, London, W.C.



Back View of Subscriber's Selector.

Sir William Crookes,

F.R.S., P.P.C.S., P.P.I.E.E, &c.

THE discovery of the secrets of Nature must always be somewhat dependent on chance. Many experiments may appear barren of the results sought for, and yet unlooked-for effects may lead to important developments. So, if one experimentalist obtains certain results, others may evolve therefrom discoveries of the greatest consequence. Crookes, by observing the effects of electric discharge in high vacua, if he obtained no immediate practical results, laid the foundation of some of our greatest modern wonders, first among them being the application of Rontgen Rays.

Sir William Crookes has spent his life in the laboratory. In 1848, when but sixteen years old, he entered the Royal College of Chemistry. The following year he gained the Ashburton Scholarship, and the year after became assistant to Dr. Hofmann, which position he held for four years. He then obtained the appointment of Superintendent of the Meteorological Department of the Radcliffe Observatory at Oxford.

In 1859 Mr. Crookes founded the *Chemical News*, and has been Editor and proprietor of that journal ever since. In 1864 he took up the Editorship of the *Quarterly Journal of Science.*

Among Sir William's scientific discoveries, the first of importance was the production, in 1861, of the metallic element Thallium, the chemical properties of which he fully investigated in subsequent years.

A few years after, his extensive investigations in vacua led to the construction of the Radiometer and other instruments for demonstrating the effects of light in space practically devoid of air. indirect result of these investigations is now everywhere visible in the incandescent electric light. It is said that Mr. Crookes' house in Kensington was the first in England to be lighted by electricity, which was accomplished in 1881.

Sir William's researches have been carried on in many different lines. He is an authority on Sanitation, having written two pamphlets on the Disposal of Sewage. Also on Dyeing and Calico Printing, on Metallurgy, on Beet-root Sugar, and on Artificial Manures, and his paper, addressed to the British Association in 1898, on the wheat supply, created great interest throughout the country. His theory on the origin of elements is that they are really compound bodies emanating from one primordial matter.

In 1888 Professor Crookes was elected President of the Chemical Society. In 1891 he was President of the Institution of Electrical Engineers, and in 1898 President of the British Association.

In 1897, on the occasion of Queen Victoria's Jubilee, he received the honour of Knighthood, in recognition of his many eminent services to science.

Sir William has been the recipient of many prizes and honours, among others the Royal medal of the Royal Society in 1875, a prize of 3,000 francs and a gold medal from the French Académie des Sciences (1880), the Ferguson medal from the Society of Arts (1885), the Davy medal of the Royal Society (1888), the Albert medal of the Society of Arts (1899).

Sir William married the daughter of Mr. W. Humphrey, of Darlington.

The Skin of the Atmosphere.

RECENT researches made by means of balloons and kites which have been equipped with self-registering thermometers, and have been sent up to great heights, reveal the existence of a layer of comparatively warm air at altitudes of between 36,000 and 56,000 ft. This layer, which we have ventured to call the skin of the atmosphere, consists of strata of air that do not follow the usual rule by which temperature diminishes with the height above the earth's surface. It has been found that the decrease of temperature with height becomes slower between 26,000 ft. and 30,000 ft., and ceases entirely at 36,000 ft. Above this height the temperature may actually begin to increase. Meteorologists, Dr. Shaw among them, who recently referred to these investigations, may have begun to wonder what were the inferences to be drawn of this upsetting of *all* preconceived opinions. But some later balloon investigations have shown that this paradoxical reversal only occurs through a layer of atmosphere —a layer which is higher up in summer than in winter, and higher in an anti-cyclone than in an atmospheric depression. Its thickness is as much as 21,000 ft. Above this warm layer of oscillating temperature, at heights of 56,000 ft., the decrease of temperature has been found to set in again. The greatest height reached by the balloons was registered as 65,000 ft., and there the temperature appeared to be about 75 deg. C. below zero.

Balloons and kites have done much to elucidate the conditions of humidity at great heights. As a general rule the percentage humidity of the air increases with the height until the first cloud layer is reached; beyond that the air becomes dry, sometimes very dry, but humidity increases again to a second cloud layer; and some of the Blue Hill kite records show that the process might be repeated a third time.

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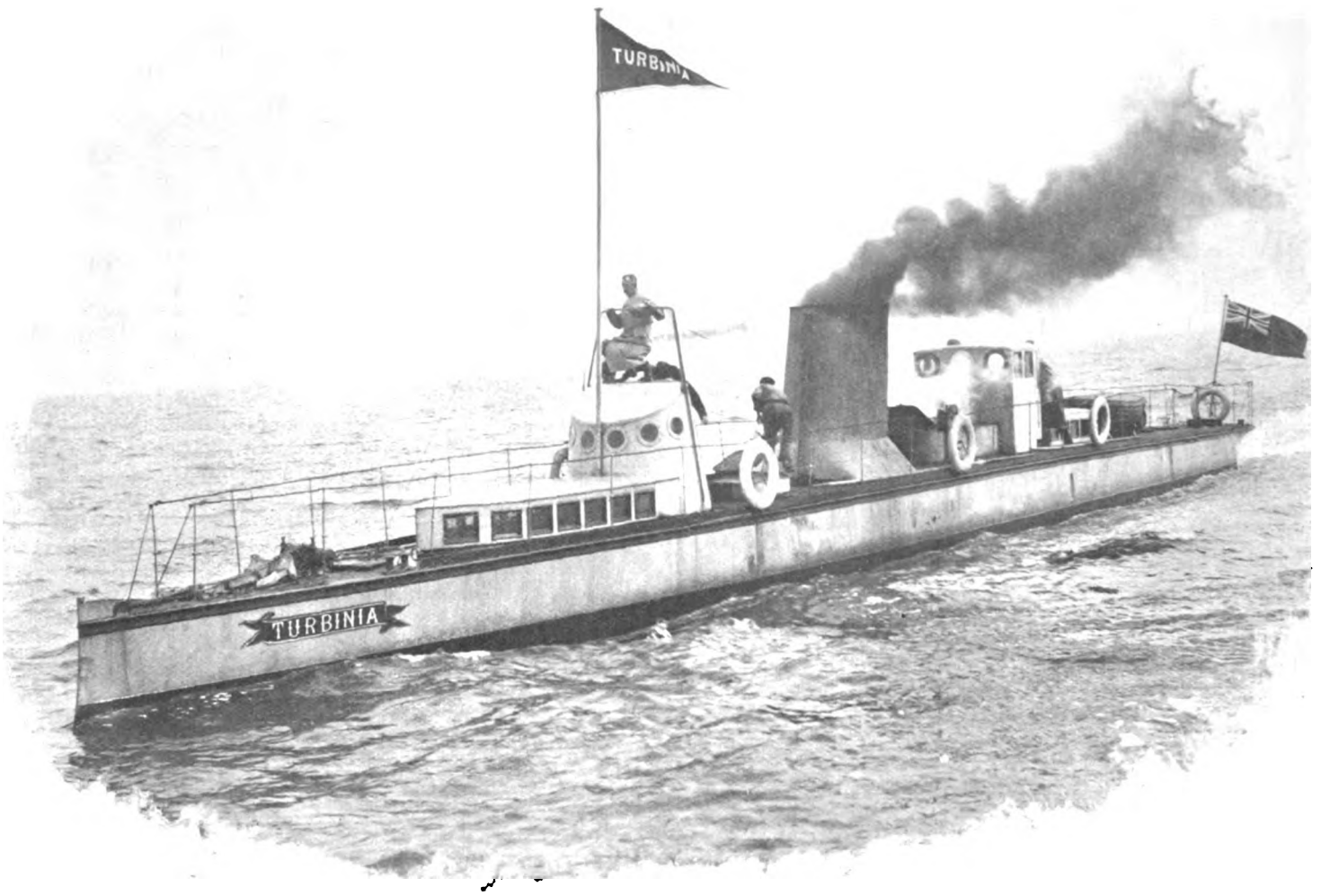
The Future of the Marine Steam Turbine.

UP to the present moment there have been built seven vessels that have been fitted with the Parsons Marine Steam Turbine. These are, in order of construction:—

1.	*Turbinia*	Experimental vessel
2.	H.M.S. *Viper*	Destroyer
3.	„ *Cobra*	„
4.	*King Edward*	Excursion steamer
5.	*Queen Alexandra* ..	„ „
6.	H.M.S. *Velox*	Destroyer
7.	*Tarantula*	Private yacht

Under construction there are now six. These are:—

1.	H.M.S. *Eden*	Destroyer
2.	„ *Amethyst*	Third class cruiser
3.	*Emerald*	Private yacht
4.	*Lorena*	„ „
5, 6.	Cross-Channel steamers for the S. E. & C. Ry. and L.B.S.C.R.	



The "Turbinia"—the First Experimental Vessel.

H.M.S. *Velox* is the only turbine-engined warship in the world, and on a preliminary trial attained a speed of 33·64 knots. She differs from the *Viper* and the *Cobra*, for Mr. Parsons found that these destroyers were not so economical as could be wished when running at ordinary cruising speeds.

A word may be said respecting the three high-speed turbine yachts. These are:—

1. *Tarantula*—built to the order of the late Col. McCalmont, M.P.
2. *Emerald*— „ „ „ Sir Christopher Furness
3. *Lorena*— „ „ „ Mr. A. L. Barber, of New York.

The most interesting of these is the *Tarantula*, the only one that has up till now been launched. She has been built by Messrs. Yarrow and Co., of Poplar, on the lines customary with torpedo boats of the first-class. As regards her hull and boilers, in fact, the *Tarantula* is identical with a Yarrow torpedo boat, the boilers being of the Yarrow water-tube type. The machinery has been provided by the Parsons Marine Steam Turbine Company, of Wallsend-on-Tyne. There are three turbines, one high pressure, one intermediate, and one low pressure, and three shafts with two screws on each, making six screws in all. The *Tarantula* is 152 ft. long and 15¼ ft. beam. Her designed speed is 24 knots and her horse-power about 2,000. This yacht attained a mean speed of 25·35 knots on trial.

The *Emerald* is being built to the order of Sir Christopher Furness. The hull and boilers are being supplied by Messrs. Alexander Stephen and Sons, Glasgow, and the machinery by the Parsons Company. The *Emerald's* tonnage is about 750, and her I.H.P. will be about 1,500. This yacht was launched last month and the machinery is now about completed; the trials will take place soon. The third yacht, *Lorena*, is being built to the order of Mr. A. L. Barber, of New York. Her tonnage is about 1,400, and she will be 260 ft. 8 in. in length and 33 ft. 3 in. in beam. The hull and boilers are being constructed by Messrs. Ramage and Ferguson, of Leith, Scotland, and the turbine machinery by the Parsons Company.

Turning now to the use of the steam turbine for passenger vessels, it must be noted that two Cross-Channel steamers are now being constructed by Messrs. Wm. Denny Bros., one for the L.B.S.C.Ry. Co., for the Newhaven-Dieppe passage, and the other for the S.E. & C. Ry. Co., for the Calais-Dover service. The latter vessel will be 300 ft. long, with a beam of 40 ft., and the former 280 × 34 ft. There will be three turbines for each steamer and each will have five propellers. The speed of each will be about 21 knots.

A few details regarding the *King Edward* and the *Queen Alexandra* might be of interest.

The *King Edward*, which commenced running on the Clyde in 1901, is 250 ft. long and 30 ft. wide. Her moulded depth is 10 ft. 6 in. to the main deck, and 17 ft. 9 in. to the promenade deck. The propelling machinery consists of three Parsons steam turbines working compound. These are placed side by side. In ordinary working, and when going ahead, steam is admitted from the boilers to the high-pressure turbine, where it is expanded fivefold. Thence it passes to the two low-pressure or wing turbines placed one on each side, where it is expanded 25-fold, and then passes to the condensers. The total ratio of expansion is, therefore, no less than 125-fold. Each turbine has its own shafting; and on each side of the wing shafts there are two propellers, while the centre one carries only a single screw. When coming alongside a pier, or manœuvring in crowded waters, the wing motors alone are used, steam being admitted directly into them by suitable valves. On her first trial the *King Edward* made 20·48 knots, thus creating a record on the Clyde and exceeding in speed most of her competitors by one or two knots.

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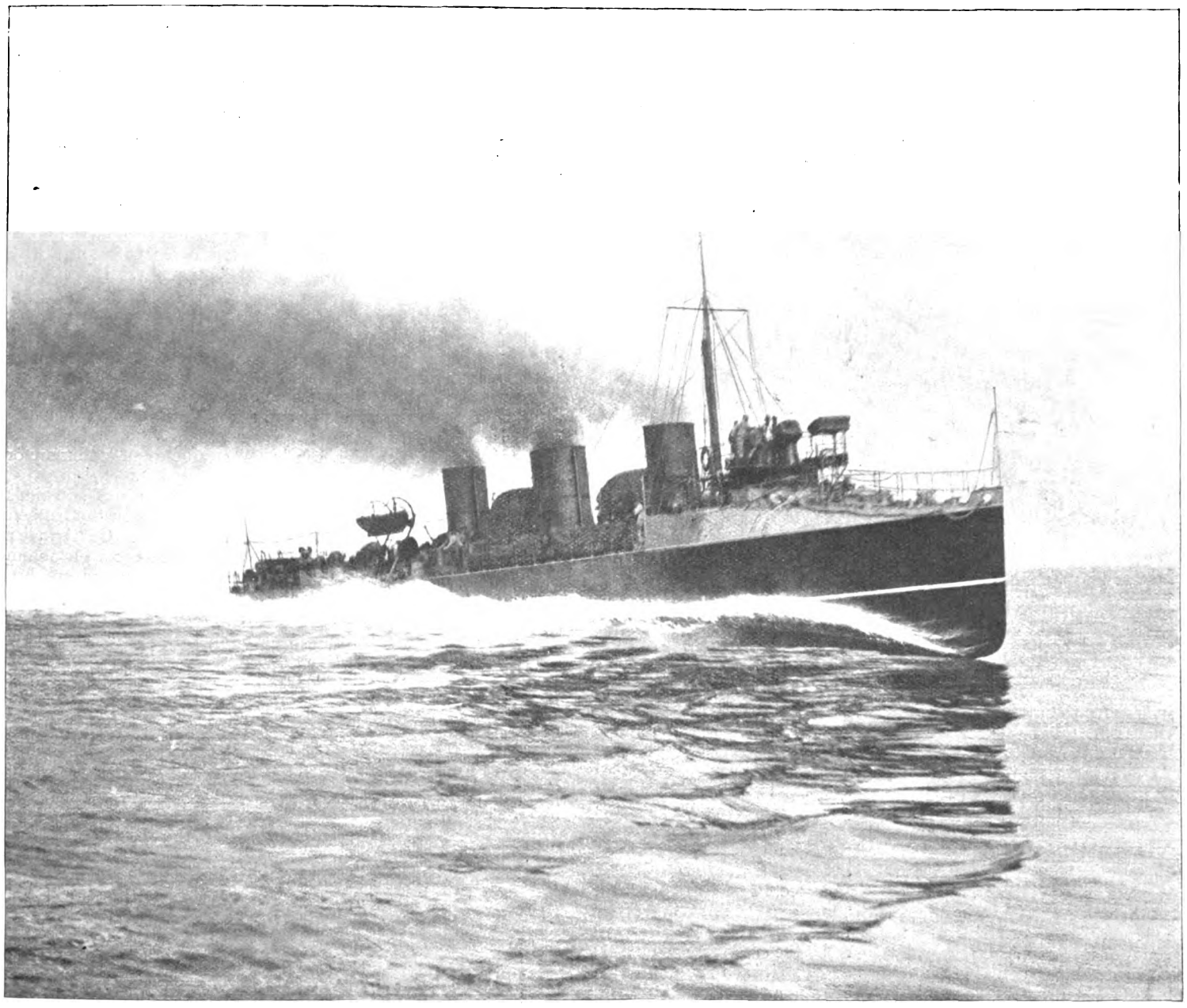
The mean revolutions were 740 per minute, the steam at the boilers was 150 lb. to the sq. in., and the vacuum 26½ in.

The air pressure in the stokehold was equal to 1 in. of water. The indicated horse power was estimated at 3,500 from model experiments, but there is no means of taking indication diagrams with this type of engine.

So successful was the *King Edward* that a new turbine vessel, the *Queen Alexandra*, was ordered. She was launched from the yard of Messrs. Wm. Denny and Brothers a few months since.

The *Queen Alexandra* on her trials made 21·63 knots, thus beating the *King Edward* and proving herself to be the fastest excursion steamer in the world.

There was another question in regard to the coal consumption of turbines. It was well known that turbine engines at a much lower power than that for which they are designed are not so economical as ordinary engines. Up to the highest speed at which the *King Edward* had been driven thre was found an always increasingly favourable consumption of coal in relation to the speed of the vessel, but there were



H.M.S. Torpedo Boat Destroyer "Viper."

no means of knowing how far this tendency might reach. However, it was ascertained that her speed would have had to be reduced to between 17 and 18 knots, as on trial, before ordinary engines, under the same conditions and at the same speed, would burn less per knot of speed; this 17 or 18 knots speed corresponded to about 50 per cent. of the total maximum power of the turbine engines in the *King Edward*. The upkeep of the turbine engines for the season had been very slight. As to cost, even including royalties charged, it was found that turbines were not more expensive than other engines, and, it was thought, with more experience in their manufacture, they would ultimately become considerably cheaper. If the *Queen Alexandra* turned out to be as successful as the *King Edward* was, it was almost certain there would be a very large application of turbine machinery.

It may be interesting to quote here a statement made by the Hon. C. A. Parsons in a recent lecture at the Royal Institute, London, on the future of the marine steam turbine.

"In regard to the general application of turbine machinery to large ships, the conditions appear to be more favourable in the case of the faster class of vessels, such as cross-Channel boats, fast passenger vessels, liners, cruisers, and battleships; in all such vessels the reduction in weight of machinery and economy in the consumption of coal per horse-power are important factors; in some the absence of vibration is a question of first importance as affecting the comfort of passengers, and, in the case of ships of war, permitting of greater accuracy in sighting of the guns.

"I have had constructed a model representing a proposed cross-Channel boat for the Dover and Calais or Newhaven and Dieppe route. She is 270 feet length, 33 feet beam, 1,000 tons displacement, and 8 feet 6 inches draught of water. She has spacious accommodation for 600 passengers, and with machinery developing 18,000 horse-power would have a sea speed of about 30 knots as compared with the speed of 19 to 22 knots of the present vessels of similar size and accommodation."

Again in a lecture delivered before the Institution of Engineers and Shipbuilders in Scotland, Mr. Parsons said that the marine steam turbine would be found to be superior or at least equal in economy of coal to the reciprocating engine when placed in fast vessels of the mercantile marine. In the case of an Atlantic liner, turbine engines would effect a reduction in weight of machinery and also increased economy in fuel, tending either to a saving in coal on the one hand, or, if preferred, to some increase in speed on the same coal consumption per voyage.

The principal advantages of the turbine system of propulsion for passenger steamers of all classes compared with vessels fitted with ordinary engines were as follows:—

(1) Increased speed for the same boiler power due to considerably reduced weight of machinery, and increased economy in steam (the advantage increasing with higher powers and speeds).

(1a) Same speed, with reduced boiler power and reduced coal consumption for the same reason as (1).

(2) Absence of vibration, giving greater comfort to passengers.

(3) Increased cabin accommodation is due to smaller machinery space.

(4) Less upkeep in machinery, and smaller engine-room staff.

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A Petrol Electric Motor 'Bus.

FOR heavy work in this country, the usual type of motor waggon selected has been the steam motor, which, though clumsy, is powerful and trustworthy. An attempt was made some time ago to adapt the steam motor to the purposes of omnibus traffic; but the evident disadvantages of its methods of consuming fuel were not balanced by the advantages it offered, and the London Road Car Company, to which it was offered, and which has been making experiments in motor 'buses, did not take it up. The Fischer Petrol Electric Motor Company have now submitted a new type of motor 'bus to the Road Car Company. Everyone is familiar with the unpleasant vibration which takes place with the petrol motor car, when the car is standing, and which is due to the fact that it is necessary to keep the engine running, while the car is at rest, as it takes sometime to start, and as when doing no work beyond overcoming its own friction, the engine only takes an explosion occasionally, the effect noticed is produced. The question also, of the transmission of the power from the crank shaft of the engine is often a troublesome one. Several speeds have to be arranged for, and this means several sets of gear wheels, which must be put in and out of gear when required to change speed, a contingency which often occurs very suddenly. The gearing employed for reducing the speed also uses up a considerable proportion of the power of the engine, sometimes as much as 50 per cent. If the gear wheels are damaged by careless driving, it may amount to very

A Trolley Waggon Equipped with the Fischer Electric Petrol Motor.

much more than this. In the Fischer Petrol Electric 'Bus, a three cylinder petrol engine, running at 600 revolutions per minute, is directly connected to a five kilowatt dynamo, furnishing current at 110 volts pressure, and the current so generated is used to drive two 5 h.p. motors, connected to the rear axle of the 'bus through ordinary spur gearing. In addition, a battery of 50 accumulators, of 90 ampère hours' capacity, is also carried by the 'bus, the accumulators being connected to the dynamo in parallel with the motors. A barrel controller placed near the driver, a hand brake, and steering wheel complete the equipment. The engine runs constantly at full load, and therefore at its highest efficiency, any current not required by the motors being automatically taken up by the accumulators, and stored for use when the power developed by the engine is insufficient to drive the 'bus, such as in hill climbing, &c. When running down hill, and when the engine would be called upon to perform no work, it still goes on running, the whole current produced being stored by the accumulators, and in addition, the motors then act as generators, and pour their current into the accumulators, acting as powerful brakes as well as adding to the store of energy. It is claimed by the inventors that, notwithstanding the conversions from one form of energy to another, which take place in the transmission of power from the engine to the driving wheels, the combination is considerably more efficient than any gear wheel transmission. They claim, in fact, a combined efficiency of 86 per cent. The 'bus to be placed on the streets of London will carry 30 passengers, and will weigh 4½ tons, including engine dynamo, motors, and accumulators. The speeds will be 12 miles on the level, and six miles an hour going up Pentonville Hill, or similar gradient. The controller will be similar to those on electric tramcars, giving five forward speeds, from 2½ to 12 miles an hour, and two reverse speeds, 2½ and 5 miles an hour. The accumulators are carried under the seats inside the 'bus, but are arranged to be removed if required from outside, so that the possibility of fumes from the acid rising to the passengers' nostrils inside the 'bus will be reduced to a minimum.

The Fischer Company are also making trolleys on the same lines for carrying goods. Our illustration shows a trolley waggon built by the Company. It is interesting to note that the North-Eastern Railway Company are stated to be going to place somewhat similar vehicles on the road to Hartlepool, to run between the two stations. The vehicles will not have accumulators. They will carry 52 passengers at the rate of 30 miles an hour, and will be fitted with four cylinder Napier Petrol engines capable of furnishing 85 brake horse-power. The cars will be 53 ft. long. The engine will drive a dynamo as in the Fischer 'bus, the current from the dynamo driving two motors geared to the wheels of the car.

Electric Thermometers.

FOR MEASURING HIGH TEMPERATURES AT A DISTANCE.

IT is already becoming a common practice in many industries to use an electric thermometer or pyrometer for ascertaining the exact temperature within a furnace, boiler, kiln, or other position where an ordinary mercurial thermometer could not be used or could not be read. The Cambridge Scientific Instrument Company now make these electric thermometers in many different patterns, suitable to varying circumstances for which they may be required. The wonder is how some of the delicate processes of annealing, brewing, &c., could have been satisfactorily carried on without any instrument to show the degree of heat employed.

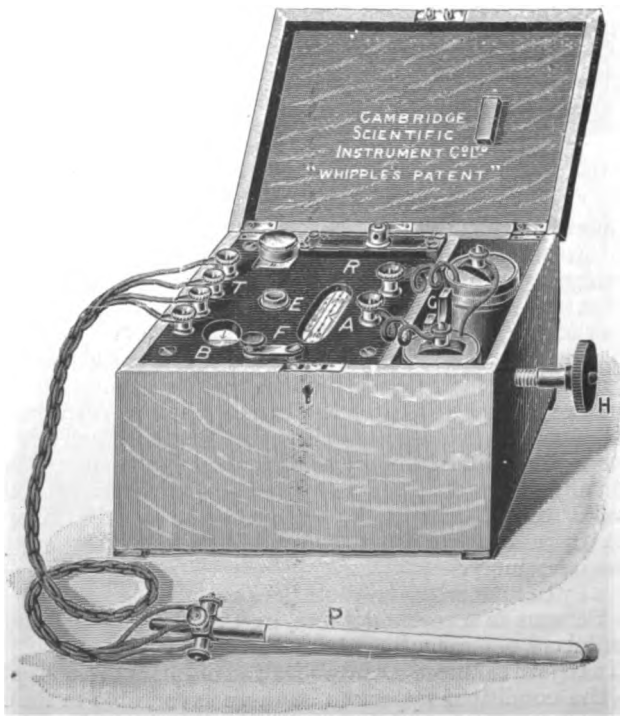
The general principle of these thermometers, or rather of that most usually used, is that the electrical conductivity of wire varies with the temperature to which it is raised. A fine platinum wire is wound on a mica frame, and is protected from the action of fumes and mechanical damage by means of a tube of metal or porcelain, this covering depending on the temperature it is required to measure. Stouter wires connect the fine platinum wires to the base of the instrument, whence long insulated wires connect it with the indicator, which is but a species of galvanometer. It will be understood that such an instrument can be subjected to great heat without danger. Temperatures up to 1,400° C (2,552° F) and more can thus be measured.

A great advantage of this method of ascertaining temperatures is that the instrument may be read at a distance from the spot. Thus a thermometer placed in a furnace may be connected with wires, and the indicator read in the manager's office, even though it be a hundred yards or so from the furnace. So, too, the temperature in a hospital ward can be seen in the engine-room, and more or less heat applied.

The instruments for noting the temperature are of two kinds, the Whipple Indicator (illustrated herewith), by which the temperature can be read off the scale in degrees Fahrenheit or Centigrade; and the Callender Recorder, in which a continuous record is automatically marked on a strip of paper. The varying temperature throughout the day, or even for a week on end, can thus be read off.

Another principle on which such instruments are made is that of the thermo-electric couple, which is capable of measuring higher temperatures. Two pieces of metal, preferably platinum and platinum-iridium, are joined and enclosed in a porcelain tube, and are connected by wire to a spinal form of voltmeter. Such instruments are not quite so accurate or reliable as those depending on the resistance of a platinum wire, but are much cheaper and therefore are useful for employment in places where there is a risk of their being destroyed.

The use to which such instruments may be applied are very numerous. In annealing furnaces, in brick kilns, dust destructors, boilers and flues; in breweries, hospitals, and even in cold storage warehouses; in fact, in all places where heat or cold is a matter of importance, they will be required.



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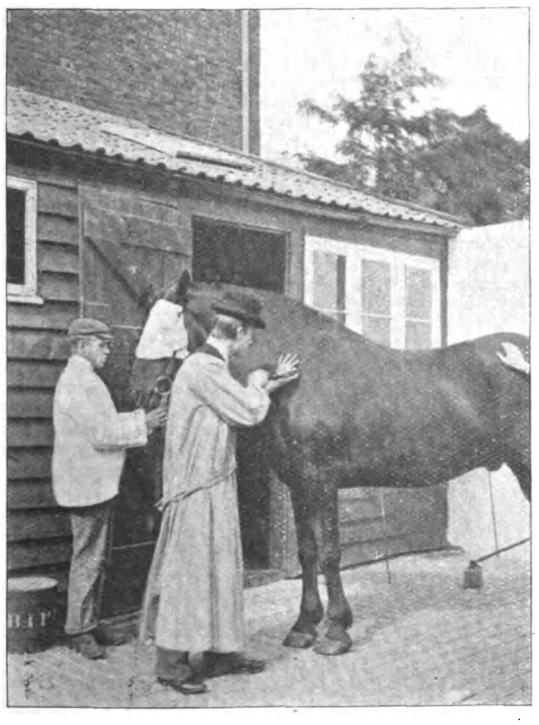
An Ally of the Blood.

PREPARING DIPHTHERITIC SERUM.

NEARLY everybody is acquainted with the working principle of anti-toxins in giving temporary immunity against disease, having become familiar with an example of the theory in practice by subjection—or it may be by conscientious objection—to vaccination. When the blood is attacked by bacteria from the outside it forms anti-bodies to combat them. It makes so many of these anti-bodies that after the invading bacteria are routed there are a considerable number of anti-bodies, rather more numerous than the population of the world, left over to meet any future attacks. Thus, after surviving a disease, the human blood remains for a longer or shorter period proof against future attacks of the same disease, and sometimes proof against the attack of a similar disease. Now there are some animals which are naturally proof against certain diseases. The barn door fowl is proof against pneumonia; the horse only takes diphtheria mildly. When the diphtheria bacillus is injected into the horse's veins, his blood produces quantities of bodies, which we shall henceforth call anti-toxins; and these anti-toxins kill off the diphtheria bacillus in greater and greater numbers. At last, by gradually increasing the dose of the poison, the horse's blood becomes more and more strong to resist the poison, until at last it is so strong that when injected into the blood of another animal—like man—the mixture of man's blood and horse's blood is able to resist a mild attack of diphtheria. At any rate, it can do so for a time. The immunised blood of the horse is what is known as "diphtheria anti-toxin." The following is a more exact and scientific statement of the foregoing explanation:—

HORSES UNDER TREATMENT.

When susceptible animals are repeatedly injected with filtered cultures of the diphtheria bacillus they after a time acquire immunity in which, according to its completeness, they are rendered, either partially or wholly insusceptible, either to the action of the diphtheria bacillus or its poisons. Experience shows that blood serum from animals possessing this acquired immunity has a greater or less power of neutralising "diphtheria or toxin poison," and when injected into other animals, of conferring a temporary immunity on them. *It also exerts direct curative action when given to animals already suffering from the effects of diphtheria poison.* It has, however, been shown that the immunity of an animal, and the anti-toxin poison of the serum do not necessarily go hand in hand; and that some horses, where immunity is great, furnish a serum which is of only smaller use to other animals. That is to say, their "blood serum" has a very low anti-toxin or curative power. The preparation of this "diphtheritic



anti-toxin" is now a very important bacteriological process, we might almost say industry, alike in Germany and in England. In England the most important institution concerned in its production, examination, and standardisation is the Jenner Institute of Preventive Medicine, which, under the direction of Professor Alan MacFadyean, the Fullerian Professor of Physiology at the Royal Institution, is responsible for so much brilliant research in bacteriology during the last few years. The horses, which are all picked animals, and which become as diphtheric subjects, friends of man in an entirely novel sense, thrive on the treatment, and gain in weight and condition. Every care is taken not to frighten them, both while they are being injected with the "filtered culture" of the diphtheria bacillus, and while their immunised blood is being taken from them. The bandage placed across the horse's eyes, which is noticeable in the photograph below, is placed there with this object.

WHAT THE ANTI-TOXIN HAS DONE.

Some statistics showing the extent to which "Diphtheria anti-toxin" has been useful may be of interest. The returns issued by the Imperial Statistical Office in Germany, show that in German towns with more than 15,000 inhabitants there occurred during the period 1885-94 more than 119,000 deaths from diphtheria or croup,

the average number being 11,904 a year. The minimum, 9,934 deaths, occurred in 1888; the maximum, 15,860 deaths, was reached in 1893. Diphtheria anti-toxin was first used on a considerable scale in 1895, and in this year the number of deaths declined to 7,266. The prevalence of diphtheria in this year was about the same as in the previous 20 years. Moreover, the decrease in the death rate was uniform over the German Empire. The logical inference from these facts is that in the year 1895 in Germany the number of deaths from diphtheria were 4,638 below the average (11,904) for the previous ten years because diphtheria anti-toxin had been largely used as a remedy.

ENGLAND.

A great deal depends on promptitude of treatment. If the remedy is delayed to the sixth day the chances of effective assistance from the serum are enormously reduced. Statistics from both English and foreign sources show that diphtheria anti-toxin serum has enormously reduced the death-rate from diphtheria, and emphasise the statement that such reduction of mortality is greatest when the treatment is begun early. The most valuable English statistics on the subject are those compiled by the officers of the Metropolitan Asylum's Board, and from them may be gathered the following figures, which include all cases for the years 1894, '95, '96. In 1894, only a small number of cases were treated with anti-toxin. In 1895 sixty-two per cent., in 1896 seventy-one per cent. of the total cases were treated with anti-toxin. It was not employed in moribund or hopeless cases, nor in those of a very mild or doubtful character. The year 1894 showed a mortality of nearly thirty per cent. among diphtheria cases, or almost a third of the patients. In 1895 it fell to twenty-two per cent., in 1896 to twenty per cent., or one-fifth of the patients, and by progressive stages it fell in 1900 to only twelve per cent., or less than one-eighth of the cases.

A Disease of Apples.

As, perhaps, is well known, several of the States of America have experimental agricultural stations, which make experiments and conduct State-supported investigations on a very large scale, for the benefit of farmers and agriculturists. This autumn the New York agricultural experiment station has had to investigate a new disease which has appeared among harvested apples. Upon what are called scabby apples, a white or pinkish mildew appears. It is followed by rotten spots, which are brown, sunken, and bitter, and which coalesce and ruin the fruit. The disease principally appears upon apples from the Niagara and Wayne counties, and among the Greening and Fall Pippins. It is ascertained that the white mildew is the cause of the disease, and that the scab makes a way for its penetration.

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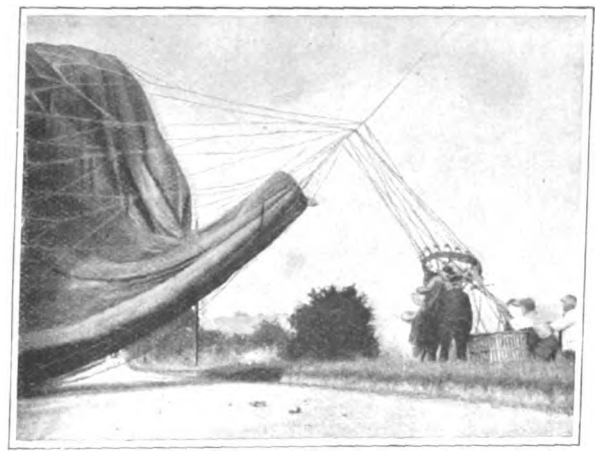
REVIEWS OF BOOKS.

"*The Dominion of Air*," by the Rev. J. M. Bacon (Cassell & Co.), 6s. Though for over thirty years no at all complete book on aëronauts had been published in England, during this year no less than four have appeared, and though they may not all have completely fulfilled what was required, it is satisfactory to note that each seems to be a step better than its predecessor. The book now before us, without pretending to be exhaustive, for the subject is now a large one, gives a really very good summary of all of importance that has been done in this line, from the days of Roger Bacon to the present time. But what one book gives, another leaves out. Though not of supreme importance, it seems rather an omission to make no reference to the quaint designs of Leonardo da Vinci. However, there is, perhaps, enough of the first chapter dealing with early suggestions and doubtful tales of experiments. The next chapter, on the invention of the balloon, is a complete and interesting little account of the eventful year, 1782-3. Inaccuracies, however, will creep in. The statement on p. 21 that the Lyons balloon was capable of lifting 18 tons is manifestly wrong. The first balloon ascents in England are well described. The invention of the



"An Awkward Landing."
"Dominion of the Air."

parachute, early military ballooning, and the first scientific ascents are in turn treated of, and passing over the journeys of Garnerin, Green, and Wise, we get to some of the practical hints on the construction and management of balloons learnt in the early days. Again following the thread of history Coxwell comes on the scene, but only because he happened to be interested in the subject, the reader is then carried back to the early trials of war balloons in France. A remark on p. 157 is well worth noting: "If it should be contemplated to use the balloon for serious or lengthened travel anywhere within possible reach of the sea-board, it must become a wise precaution, if not an absolute necessity, to adopt some form of car that would be of avail in the event of a fall taking place in the sea." Very true, but how often has this precaution been adopted, even by the author himself? The ascents of Glaisher and Coxwell are, of course, fully related, and those of several foreign aëronauts follow. The utility of balloons in the Siege of Paris is described, and then the subject, so much to the fore at the present time, the navigable balloon, is entered upon. The year in which the first

"Above Summer Clouds."
"Dominion of the Air."

engine-propelled airship, that of Giffard, ascended, is not given, although most readers would be interested to hear that it was no less than a half a century ago. After a full and harrowing account of the "Zenith" disaster, comes "a chapter of accidents." But here, again, comes a slight confusion of dates, for after describing the disappearance of Mr. Powell in 1881, we are suddenly transported back to the de Groof affair of 1874. Other distressful tales are narrated, too, all of which should be carefully taken to heart by all aëronauts, and then we gladly turn over to a new subject, "The coming of the Flying Machine," when a short description of Langley's, Maxim's, and Lilienthal's experiments is given. The parachute, in the hands of "Professor" Baldwin, "was to lend its aid to the navigation of the air with a reliability never before realized." Though how it has done so is not clear. A whole chapter is devoted to "the Story of the Spencers," after which we again make a jump back to the year 1862 to trace the history of military ballooning in England. After an account of Andre's tragic, if foolhardy, voyage, we get to the "modern airships" of Zeppelin and Santos Dumont and other aëronautical events of the past few years. Some observations on "the possibilities of balloons in warfare" and on "the constitution of the air" end up the book, which is a really very complete and well-told history. If not technical, it is entertaining, and there is all too little of the author's own exploits in the dominion of the air.

"*The Lecithans. Their Function in the Life of the Cell*," by Waldemar Koch. Preprint from the University of Chicago Decennial Publications, Vol. X, 12 pp. The University of Chicago Press.

In every living cell there are found a number of closely related phosphorized fats containing nitrogen for which the group name Lecithans is proposed. These substances have not been very generally studied since Hoppe Scyler's investigations, more attention having been given to the proteids. The lecithans are found to be of value to the cell in their relation to the inorganic constituents and also by entering into the metabolism of the cell. A method for the quantitative ostination of these substances is described.

In *The Battle with the Slum*, Mr. Jacob A. Riis continues his studies of municipal and social reform in New York, urging that "whether from the point of view of the citizen, the philanthropist, or the Christian, the slum is the poorest investment a city can make." He notes the great changes wrought under the leadership of President Roosevelt, till the iniquities of Tammany are at last rendered impossible. Mr. Riis looks to the future of the young as well as to the question of housing. New schools have been everywhere established, and with them, as far as possible, playgrounds and parks. He tells of roof playgrounds in crowded quarters, large enough for two thousand children to use, and open in the evening for the elders also. He claims that these public recreation places are solving the question of Hooligan gangs. On the immigration question also he speaks with hope, for the young, well trained and well housed, grow up good and loyal citizens, and it is chiefly the bad housing and neglected childhood that has made the Italian and the Jew a menace to New York. "Less law and more enforcement," is his gospel, and justice to the poor instead of charity. The book contains many photographs of slums now swept away, and of the new tenements replacing them. The book is published by the Macmillan Co.

Messrs. Macmillan have just issued a translation from the French of M. Ostrogorski's work on *Democracy and the Organisation of Political Parties*. To the translation by Mr. Frederick Clarke a preface is prefixed by the Right Hon. James Bryce, which emphasises the importance and unique character of this study of the modern party system—the organisation of political forces which exists apart from recognised political institutions. The work is chiefly a detailed study of the party systems of America and of Great Britain, in their growth and in their working; and the picture of political life thus presented is gloomy enough—more gloomy in respect of England than Mr. Bryce thinks warranted. Towards the close the author suggests a new method of temporary unions for special ends, to supersede the existing permanent parties.

"*Knowledge*," *Diary and Scientific Handbook* ("Knowledge" Office), 3s., should be a useful companion to astronomers who like their information combined with a diary with a page available for each day. Some may prefer the handbook separate, and many, we think, will not need so large a volume for their daily records. However, with diaries, it is a case of so many men, so many requirements. As a handbook, the matter is almost entirely astronomical, except for a few small tables and lists and some short original articles on microscopy, botany, crustaceans, and meteorology. There are some interesting little star maps of "the night sky" each month, fully described, and a considerable amount of other useful astronomical information. The cover is not quite a success. It takes a prolonged observation to discover that an oyster-like design in the centre is intended for the moon. Presumably stars are dotted all over the rest of the space, including the shaded side of the moon.

Whitaker's *Almanack* for 1903 calls for but little comment, since the work of former years is so well known and its excellence so unquestionable that our readers scarcely need to be reminded of it. All we need say is that the new year's issue is more complete than ever. Special articles are given on "the Progress of Astronomical Science" and other astronomical subjects, on "Storms and Floods," "The Year's Weather," on "Earthquakes and Volcanic Eruptions," on "Geographical Progress," "The Great Siberian Railway," and on "Wireless Telegraphy," and we can only repeat, what everyone knows, that the book ought to be on the writing-table of every educated Englishman.

Whitaker's *Peerage*, though hardly to be classed as a scientific work of reference, is one of the greatest utility. To those who are not well acquainted with the book, it is necessary to explain that though called a Peerage, and its secondary title is "a directory of titled persons," it is, in reality, a complete list of all those who are "anybody," even a D.S.O. or an M.V.O. entitling the holder to have his name, address, and short account of his life and services to be recorded.

Ratcliffe's *Guide to the South African Press* (Ratcliffe and Dunbar) is a most useful book of reference for anyone having dealings or interests in that country. It not merely contains details of all the newspapers published in South Africa, but also has a list of those in all other parts of Africa, including Egypt and Algeria. A lot of information is also given on such subjects as Customs Tariff, Railway Tariff, Imports and Exports, Licences, &c., and many statistics about the countries concerned. A very good map, quite up to date, is included,

Colour and the Chemist.

A LESSON FOR THE COLONIES.

A COLLECTION of colours and the materials used in the production of colours has just been dispatched to the permanent New South Wales Museum at Sydney, which is not only interesting as displaying the present stage of the colour industry in the United Kingdom, but which may prove a useful object lesson to the "younger nations" if they have the wit to derive from it the maxim that the painter Etty once taught. A dilettante once asked him, "With what do you mix your colours, Mr. Etty?" "With brains, Sir," growled the painter. The collection of colours soon to be seen at Sydney preach over and over again that in the colour making industry brains are the chief thing needed and that the future of industry and manufacture is bound up with the application of scientific knowledge.

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Industrial History.

The history of colour-making in England shows that it is the lack of scientific education which has cost this country her supremacy in a branch of industry which once was hers almost exclusively. Some of the gaily coloured bottles record what may be described as the history of the rise and fall of great British industries. For instance, there are half a dozen flasks of colourless liquids, or liquids containing feathery crystals. How do they tell the history of colour? Well, rather more than a quarter of a century ago Dr. Perkins discovered what we call the aniline dyes. He found that by using strong acids, let us say, roughly, by applying strong sulphuric acid to naphthaline he could produce certain colours artificially. What takes place in this case is that the sulphuric acid is a "carrier of oxygen," carrying it over the naphthaline; and thus by taking the place of costly oxidising processes, produces artificial colours cheaply. In this way, again, we are describing roughly what happened; "alizarine" or Turkey red was produced, and at a blow the use of the madder root in making this colour collapsed and disappeared. So far, so good for England. It was first to use the aniline dye processes. Then came Dr. Messels, and Dr. Messels improved on Dr. Perkins' first idea. Why not save the sulphuric acid of which tens of thousands of gallons are used? And this was done by the discovery of what is called the catalytic process and the use of "sulphuric anhydride." "Sulphuric anhydride" represents the stage of ingenious commercial cheapness. The employment of sulphuric anhydride enables the oxidising processes which produce the colour to act as effectually as before, but after the work is done the acid can be recovered by passing the products of the chemical combinations over spongy platinum. In this way the production of the indigo dye by artificial means, which hitherto had been a laboratory experiment, became commercially possible, and Dr. Messels' new method paved the way for that "synthetic indigo" which is driving the natural dye fast out of the market. But whereas it was Dr. Perkins who found the first method and gave it to the English trade, it was the Germans who saw the possibilities of the second development, and who are now reducing indigo planters to bankruptcy. Last year the output of artificial indigo doubled; the export of the natural dye fell sixty per cent.

The Widow's Cruse.

Then in another set of bottles, next to these which contain the greens and reds produced from lead, and the yellows produced from zinc, for printing and lithography, are the sodas—the "caustic potash," the "hyposulphite of soda," the "soda ash," which were the invention of poor Monsieur Le Blanc, who died in a workhouse. He found a new method of producing soda, instead of getting it from seaweed, and so held out to others the prospects of fortune from a new industry. But the new industry shrivelled in France in the Revolution days, and while Le Blanc went bankrupt the invention was brought to England. The wide-awake English manufacturers, as wide-awake then as their German rivals now, seized on it; and for half a century it stood as one of the staple unshakable industries of England. Then Brunner and Mond hit upon a plan similar to that described in the manufacture of aniline dyes for saving and restoring the agents of the chemical process. Carbonate of ammonia was found to mix with brine, and this produced carbonate of soda, plus chloride of ammonium. And from the chloride of ammonium the carbonate of ammonia could be got back again and saved—a widow's cruse process we might call it. Thus, here again, the old method was pushed against the wall. Here, again, the Germans were the pushers.

Good from Evil.

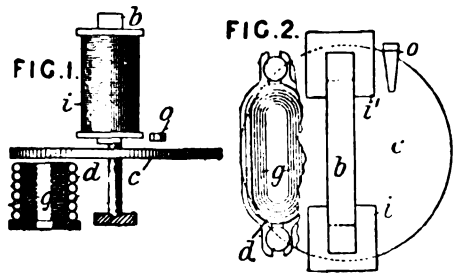
Two more examples, one old, one new. When the old King of Sicily found that all the world wanted the sulphur of the Sicilian mines for dye processes, he clapped a duty of £15 a ton on the produce. This revolted the economical chemist, who set about finding an alternative method of extracting sulphur from ores. Consequently to-day the jar of yellow "manufactured" sulphur takes its place among the British colours. But the King of Sicily builded worse than he knew, and better for the chemist, for in extracting sulphur from ores the chemist extracted copper as well, and even silver and fine gold. Wherefore the Kingdom of Sicily is forgotten, and her industry decayed. Last of all there are the blue crystals of copper sulphate; but this is a story of the future. The copper sulphate is mixed with water and lime, and produces the "concentrated Bordeaux mixture" with which the French vine grower, the American apple grower, and, perhaps, one day, the Irish potato merchant and the Australian peach producer, must now sprinkle their crops in order to keep off blight.

Black Pigment.

A NEW source of black powder suitable for paints, and especially for printing ink, has been found by M. Hubon in the carbon resulting from the disintegration of acetylene gas by an electric spark.

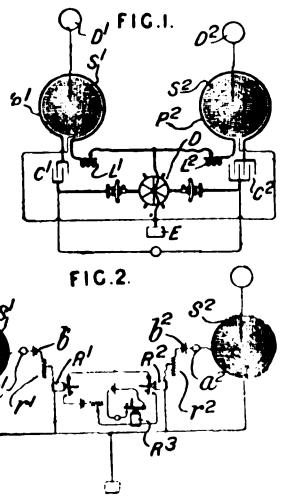
Recent Patents.

14,562. Electricity, Measuring.—CATENHUSEN, F. L., Friedrichstrasse, Berlin. July 17.



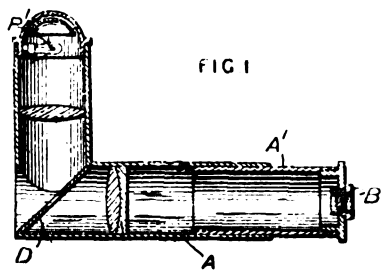
Energy meters.—A motor meter for a single alternating current has a conductive disc *c* revolved by the co-operation of a horse-shoe shunt electro-magnet *b* with a main current coil *d*, which has no iron core and is placed at some distance from the spindle. The electromagnet *b* has two equal coils *i*, i^1, connected in series between the mains, and such that the iron is not magnetized so high as the bend in its magnetization curve. The main current coil *d* consists of a few large turns, and is separated by a conductive plate from a coaxial fine wire coil *g*. The coil *g* is connected in series with a non-inductive resistance between the mains, and the point of connection between the coil *g* and the resistance is joined by a second resistance to the connection between the coils *i*, i^1. The arrangement is such that the coil *g* co-operates with the magnet *b* to produce a resultant magnetic field in quadrature with the field due to the main current coil *d*, when the load is non-inductive. One of the two resistances may be inductive, and that in series with the coil *g* may consist partly of another coil acting on the disc. Two or more sets of coils may be provided to act on one disc, as described in Specification No. 14,614, A.D. 1898. A metal piece *o* serves to neutralize the effect of inequality of the windings *i*, i^1. The invention is based on that described in Specification No. 18,789, A.D. 1900. The main objects are to obtain a large constant brake effect from the electromagnet *b*, and a long range of proportionality between the main current and the velocity of the disc.

14,579. Transmitting Electrical Energy. LAKE, H. H. 45, Southampton Buildings, Middlesex.—(*Tesla, N.; 46, East Houston Street, Manhattan, New York, U.S.A.*) July 17.

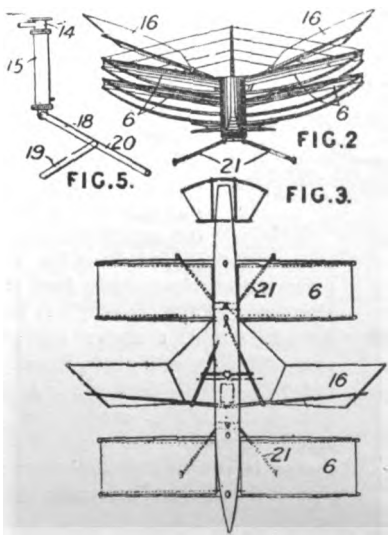


Two or more kinds of electric disturbances are generated, and a distant receiver, which has two or more elements severally responsive to the different disturbances, is dependent for operation upon the resultant action of such elements; a high degree of selection may thus be obtained. Figs. 1 and 2 show a simple arrangement, in which Fig. 1 shows a transmitter and Fig. 2 a receiver. Coils S^1, S^2 are connected to earth at E and to elevated terminals D^1 D^2. The coils are excited by primaries P^1, P^2, in which circuits are arranged inductances L^1, L^2, condensers C^1, C^2, and a circuit breaker D. The receiver comprises coils s^1, s^2, sensitive devices a^1, a^2, batteries b^1, b^2, adjustable resistances r^1, r^2, and sensitive relays R^1, R^2. The operating or controlling relay R^3 is only affected when both the relays R^1, R^2 are affected simultaneously. Instead of having a double or multiple transmitter, it may be arranged to produce certain successions of waves &c., and the relays are only affected when such a succession is received. In a modified arrangement, synchronously-rotating contact-breakers are employed at each station. The system is not limited to wireless telegraphy &c., but may be applied to the transmission of energy by cables, &c.

14,962. Ophthalmoscopes. HARRISON, G., 11, Southampton Buildings, London, W.C.—(*Zeng, H. L. de; Philadelphia, Pennsylvania, U.S.A.*) July 23.



A telescope A has mounted in front of it a reflector D to throw light from a source P^1 into the eye being examined. The necessary corrections are determined by the adjustment of the eye-piece B against a scale A^1. The mirror D may be fixed between the objective and eye-piece, and the illuminating-tube may be fixed parallel to the telescope. The telescope may also be fitted behind a retinoscopy mirror which may be fitted on the end of the telescope by a universal joint.



16,856. Aerial Machines. MOY, T., 8, Quality Court, London, W.C. Aug. 22.

The machine is supported by a series of curved aëroplanes 6, and is propelled by a pair of feathering wings 16 operated by the movement of the heavy steam cylinder 15, which works over the fixed trunk piston 14. An important feature of the invention is the upward recoil of the machine produced by the rapid downward movement of the heavy cylinder 15. The exhaust from the cylinder passes through the jointed pipes 18, 19, which guide the cylinder; the rod 20 operates the feed pump. Spring legs 21 can be moved to one side or the other to alter the centre of gravity for steering purposes; they also assist in starting.

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FIG.1.

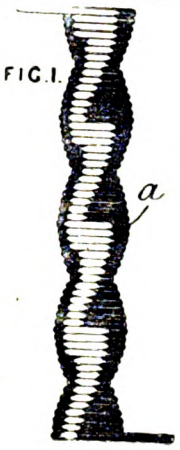
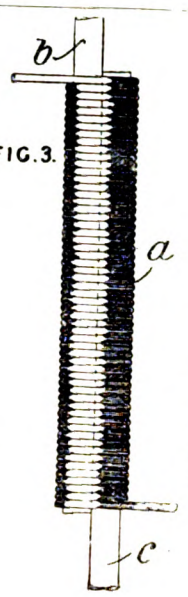


FIG.3.



14,917. Electric Couplings. FISCHER-SCHAAD, E., and SCHNEIDER, H., both of Zuchwylerstrasse, Solothurn, Switzerland. July 22.

A sleeve *a* is formed of a continuous wire wound in a helical manner as shown in Fig. 1. By turning the ends of the wire, the sleeve is made substantially straight, when the conductors *b*, *c* can be inserted, and are firmly held by the torsion of the coil *a*.

FIG.1.

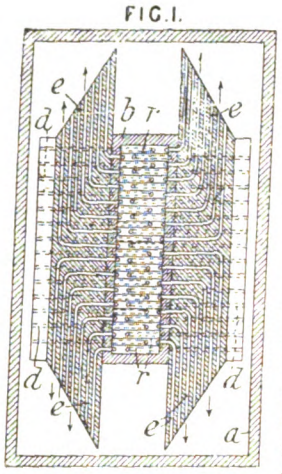
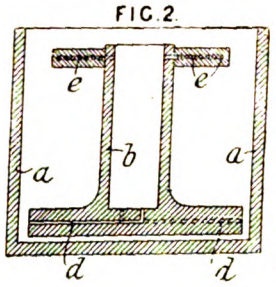


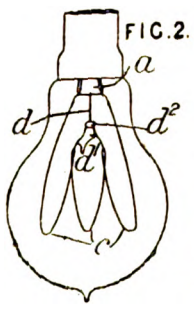
FIG.2.



14,946. Electrolysis. HAAS, M., Aue, Saxony, Germany. July 23.

Bleaching-compounds, obtaining.—In apparatus, such as is described in Specifications No. 10,215, A.D. 1899, and No. 9331, A.D. 1900, and in which double-pole electrodes are used and thereby divide the cell into several compartments, long narrow channels are arranged to form the only liquid connection between these compartments. In the form shown in Figs. 1 and 2, the cell *b* is contained in an outer storage vessel *a*, and is divided into compartments by divisions *r* forming the intermediate electrodes. The liquid enters the electrolytic apparatus through long narrow non-conducting channels *d*, each of which leads to a separate compartment. The liquid flows out of these compartments through narrow channels *e* back to the storage vessel. If the electrolytic vessel is connected to an upper storage vessel and a lower collecting-vessel, long narrow pipes are led from the storage vessel to near the bottom of each compartment of the cell, and from the top of the latter to the collecting-vessel. In another form, a long narrow pipe connects each compartment of the cell to the following one, so that the liquid passes through each compartment in turn.

FIG.2.



17,070. Electric Lamps. REINMANN, A. L., Westmoreland Road, Huyton, Lancashire. Aug. 26.

Incandescent lamps.—A filament *c* is supported at one or more points between its ends by loops or cemented joints on wires d^1, which are fused in a glass bead d^2 on a central wire stem *d*, set in the glass base *a* of the lamp. In one arrangement, the middle of the filament is supported by the stem *d* itself. The stem *d* may otherwise consist entirely of glass or equivalent material.

FIG.1.

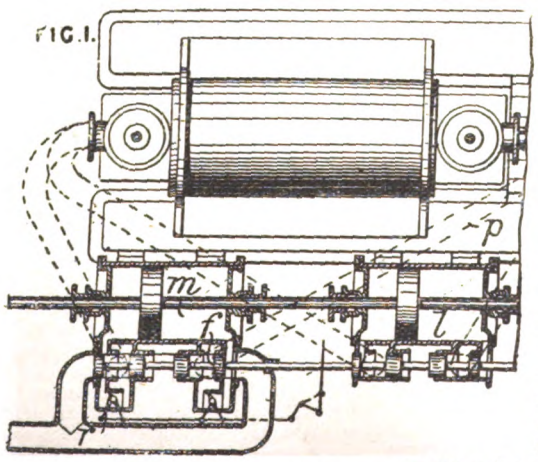
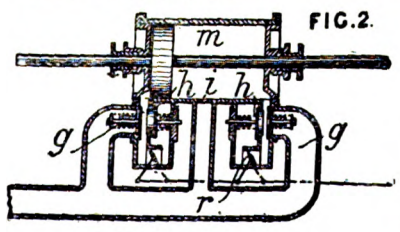


FIG.2.



17,091 Gas Engines. KÖRTING E., Körtingsdorf, near Hanover, Germany. Aug. 26.

Two stroke cycle gas engines are supplied with air and gas by different pumps *l*, *m*. The air pump always delivers its full charge, but the gas pump is provided with a bye-pass and valve *r* under the control of a governor, by which the pump *m* draws back again from the pipe *p* some of the gas which it had delivered. Fig. 1 shows the gas pump provided with piston valves *f*, and Fig. 2 with beat valves *g*, *h*. The piston in Fig. 2 over-runs a port *i*, through which some of the charge is returned to the suction pipe on the compression stroke.

Microscopy.

OUR contemporary, *Knowledge*, which completes with this year its twenty-fifth volume—a record of accumulated research and investigations, of which its present conductors, no less than its founders, may well be proud—is desirous of giving publicity to its intention of devoting a larger proportion of its space than hitherto to microscopy. Among those who have promised to contribute are the following:—Mr. Rousselet, "How to Collect Rotifers," and "How to Examine Pond Life under the Microscope;" Mr. C. D. Soar, "The Collection, Examination, and Preservation of Water Mites;" Mr. Earland, "Coccoliths and Coccoopheres;" Mr. Wesché, "The Mouth Parts of the Tsetse Fly in Comparison with those of the Gnat, Gad Fly, etc.," and notes on entomological subjects; Mr. F. Noad Clark, "The Photography of Opaque Objects;" Mr. Sanger Shepherd, "Photo-Micrography in Natural Colours;" and other similar articles will appear.

"KNOWLEDGE," which has for long made rather a speciality of microscopical science, announces an attractive programme of articles on this subject for 1903. This department is conducted by Mr. M. J. Cross, the well-known author of "Modern Microscopy," and among the forthcoming articles are some by Messrs. Rousselet, C. D. Soar, Earland, Wesche, F. Noad Clark, and Sanger Shepherd.

Royal Institution Lectures.

PROFESSOR HELE-SHAW'S Christmas Lectures at the Royal Institution have already dealt with the applications of the motor to road traction, with special reference to the electric automobile. To-day's (Jan. 1st) lecture will consider the position of the motor in its application to railways, the steam-engine being especially described and discussed. The adaptation of electricity to railways is the subject of the fourth lecture on Saturday, Jan. 3. Twenty-five years ago no electric railway existed, and Prof. Hele-Shaw will trace the development of the electric motor from that date. Having concluded that the locomotive carrying its own accumulator is less suitable for rails than for roads, he will turn his attention to the state of electric traction in this country, and refer in turn to the first successful electric railway in this country at Portrush; the electric overhead railway at Liverpool; the electric railways of London; the difficulties and advantages of the transmission of electricity; the great development of the electric tramway, and the reasons; high-speed travelling on electric railways; Behr's lightning railway; the lightning railway between Liverpool and Manchester; and special precautions for the prevention of accidents. The remaining two lectures, to be delivered on Jan. 6 and 8 respectively, will deal, the one with the self-propelled ship, and the other with the flying machine.

The Materials of Paper.

FEW people have any idea of the large number of materials, woods, grasses, and leaves among them, which may be used to make paper. In the United States a list of all such materials, together with micro-photographs of their fibres, has been prepared by Messrs. W. R. Whitney and A. E. Woodman. The list and the diagrams have been prepared for chemists, and the examination of the fibres of paper to determine the nature and source of the raw material is a matter of considerable importance, not only to those directly interested in paper manufacture, but to the analytical chemist who may be called upon to take up the question, with only a slight previous acquaintance with the subject. An astonishing number of possible sources of paper material are disclosed by the diagrams and their description, though the authors remark that the hard woods which they catalogue among the rest have not hitherto been profitably employed in paper-making. Their fibrous composition, and its characteristics, are included chiefly in order to make the catalogue more complete. In order to prepare the material for examination, pieces taken from various portions of the paper are torn into small bits. They are boiled in a weak solution of caustic soda; and then burned in a fine sieve, and washed free from alkali. This pulp is shaken up with water, and finally inserted either temporarily in a mixture of glycerine and water, or permanently in glycerine jelly or Canada balsam.

The list of fibres thus examined includes the fibres of paper mulberry, Manila hemp (used in Manila wrapping paper), century plant, linen (cultivated flax), jute, hemp, wool (which is employed in decorative papers for facing), spruce, fir, balsam, larch, and hemlock—the length and strength of the fibres of the last five fit them for the paper of newspapers—pine, redwood, red cedar, arbor vitæ, cypress, banana, chiva grass, poplar and birch—which have no great length or strength of fibre, but are very useful for the papers of the Yellow Press, and for cheap books—gum, cottonwood, esparto grass, magnolia, holly, and a tree called the "Tree of Heaven." The last-named material ought clearly to be used for the "War Cry."

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The Science of Illusion.

SOLUTION OF MYSTERY NO. 3.—MATERIALIZATION.

THE explanation of this manifestation is simple. When the urn is brought on to the stage and the smoke begins to rise, a gauze drop curtain, of the same colour as the background, is lowered close behind the urn. This curtain is so formed that though its lower end is transparent gauze, it is made gradually thicker. Thus the bottom six feet or so may be plain gauze, the next six feet double, the next treble, and so on, until after a certain amount of it is lowered (and the part lying on the ground carefully spread behind by an attendant) it is so thick as not to be seen through. When it is thus fully lowered the lady simply walks on behind this curtain, places a small stool close behind the urn, and stands on it as the curtain is slowly raised, enabling her to be more and more clearly seen. After the desired interval the curtain is again lowered, and she walks off unseen.

MYSTERY NO. 4.—THE TRANSMITTED CARD.

THIS may appear like a very ordinary conjuring trick, but it may be repeated again and again under varying conditions, but will only be the more mystifying to all beholders. The performer brings on to the stage two small tables. These may be closely examined by any of the audience. They are then placed a short distance apart near the centre of the stage. The performer next takes a card—either a playing card or, what is still better, a visiting card borrowed from any member of the audience—and places it carefully on one of the tables, showing clearly that the card is there, and that he does not change it for any other card. Next he borrows two hats from gentlemen in the audience, and places one on each table. He makes it quite clear that in doing so he does not disturb the card, for it may still be visible under the brim. Various other arrangements are then made to demonstrate that no trickery is possible, such as placing a newspaper on the floor under the tables, laying a stick or umbrella on the table beside the hats, etc. The performer now produces a pistol and presents it at the hat under which the card is. He fires, and then deliberately lifts up the hat, when it is seen that the card has disappeared. On lifting the second hat the card is seen lying beneath it on the other table! In case there should be any suspicion that the performer is not acting in an honest and straightforward manner, any member of the audience may be delegated to lift the hats directly after the pistol is fired, but the result will be the same.

Prize Competition.

ONE of the principal objects of this journal being to encourage and foster the introduction and propagation of new ideas, the proprietors have decided to offer a series of money prizes to those who, in their opinion, send in the best and most practical solution of certain problems which will be set each month.

The designs must be sent in within a fortnight of the publication of the problem, *accompanied by the coupon* cut from this paper. Marks will then be allotted by the judges, and the competitor gaining the greatest amount of marks each month will be awarded the monthly prize of ONE GUINEA. But in order to encourage clever inventors, and not merely reward those who may happen to hit upon a happy idea, a GRAND PRIZE OF **ONE HUNDRED POUNDS** will be awarded at the end of the year (*i.e.* after 12 problems have been set) to that inventor who shall have gained the greatest aggregate of marks during that period, provided he shall have gained at least *30 per cent. of the full marks* in at least six of the competitions (whether he has gained a monthly prize or not).

In the event of an equality of votes or other exceptional circumstances, the proprietor will decide on the fairest method of distribution.

The following rules must be strictly adhered to, and solutions sent in not in compliance with them will be disqualified.

1. The solutions sent in must be concise, yet fully descriptive of the idea intended. To comply with this they must not exceed 300 words, and not more than two simple diagrams should accompany it.
2. Solutions will be published as considered desirable by the editor.
3. Competitors may obtain patent rights for their ideas, but they must run all risk of the publication in this paper interfering with the obtaining of such rights.
4. The number of marks awarded to each solution will be published every month. Competitors may send in their designs under a fancy name for publication, but their true names and addresses must be inserted on the coupon, which, in the event of their winning a prize, will be published.
5. The same person may send in two or more solutions so long as a separate coupon accompanies each.
6. Novelty of design is not a *sina qua non* (since this would be extremely difficult to prove), but only the person sending a description with the coupon is entitled to reward.
7. It would add to the value if a statement be added to say if the design has been practically tried; but to corroborate this the inventor may be called upon to give a demonstration before receiving a prize.

Results of last month's Competition.

"PROTRACTED ESCAPEMENT."

(Full marks 100).

R. FENTON (**90**). A metal tube is bent in the form of a helix and supported on trunnions at the centre. A steel ball fits loosely inside so that it may roll down through the tube from top to bottom. Each end of the tube is fitted with a small piston, to be driven outwards when the ball strikes against it. The piston rod actuates a lever which releases one cog of a wheel of the clockwork. On the trunnions a small wheel is mounted, geared to the clock, so that when the latter is started the spiral tube makes a half revolution and the ball thereby brought to the top ready to repeat the operation. *This seems quite a good solution, and might well be tried practically.*

E. M. F. (**70**). A heavy top or gyroscope is started spinning by the clockwork. Small weighted levers attached to the circumference fly outwards by centrifugal force and act on a catch which stops the clockwork. When the top slackens, the weighted levers again release the clockwork, which gives a fresh impetus to the top. *Quite a reasonable solution, though the details given are somewhat vague.*

KHARKI (**50**). Put simply, this idea is to delay escapement by causing a piston with a small hole in it to move through a cylinder filled with glycerine or some similar viscous liquid. *The idea is not bad, though the method of carrying it out is not very neat.*

R J. M. (**50**). An apparatus somewhat on the principle of the well-known egg-boiler alarm. A small hour glass is pivotted about its centre and caused to make a half revolution by the clockwork when run down. *Good in principle, but not quite so neat as some of the other solutions.*

QUADRANT (**45**). A lever, with fork and pallets at one end engaging with escape wheel, and on longer arm a toothed quadrant engaging a pinion on axis of balance wheel, which enables the spring to be wound to a greater extent. *A practicable arrangement, though it would probably only retard the motion in a small degree.*

FRED (**40**). This is a purely electric clock in which an electro-magnet, periodically connected up, gives impetus to a spinning wheel. *The source of electricity is the great practical difficulty.*

L. R. CONNOR (**35**). Powerful clock-work actuates two pistons driving water through small valves into reservoir, valves regulated by a governor driven by the clock-work. *A good idea theoretically, but the pumping of water is hardly a practical way of regulating clock-work.*

HUMBER (**35**). A strong mainspring is made to wind automatically a much weaker spring at intervals. The latter is regulated in the usual way by a pendulum. *This may be practical in certain cases, but it would usually be simpler to add another wheel to the chain of gearing between the strong spring and the escapement.*

"HARDSTAFF" (**30**). A "double three legged wheel" is revolved by the clockwork. Two stops alternately check these legs. The stops are actuated by electro-magnets, the current to which is switched on by the motion of the pendulum or vibrator. *The dependence on an electric current is not very sound, and if it was, could be better carried out by other mechanism.*

CYRIL BURRAGE (**20**). Two springs actuate the mechanism. When the larger one has run down it releases a catch which separates the connection of the large spring and at the same time connects cogs transmitting power from the smaller spring to the mechanism. *It is not very clear how this arrangement delays the escapement. This seems to be the same as if two wound clocks were provided, one of which is started by the other when the latter is run down.*

CAP. (**15**). On the arbor of the main spring is mounted an arm, on the inner end of which is a pawl engaging with the winding ratchet. A stop periodically releases the arm, which, actuated by a spring, flies back and causes the pawl to wind the spring a little. *This idea of partially re-winding a spring by its own action does not appear to be a practicable one.*

SCIENCE (**5**). Two springs are geared together so that when one is wound up full the other is down. As the one runs down the cog wheel will turn and wind up the other. "As long as it is kept in order there will be a continual power at work." *This sounds very like perpetual motion. If spring A, in running down, is capable of winding up spring B, it is manifestly impossible for spring B to fully wind up spring A again.*

P. L. PRESTON (**5**). *A somewhat similar idea.*

As a dispute has arisen regarding the award of the prize this month, the decision must stand over until the matter has been further investigated.

We regret that some uncertainty seems to exist as to the exact date by which solutions must be sent in. The journal is published on the first of each month, and is sent out to the trade a day or two before. In order to make this point clear it will in future be stated on the coupons by what date they must be sent in.

The subject for January will be—

REGULATING BALLOONS;

that is to say, a method by which an ordinary gas balloon may be caused to rise or sink at the will of the aeronaut, without necessitating the expenditure of gas or ballast.

(Coupon to be delivered at this Office not later than January 15th.)

COUPON.

To the Proprietor, ILLUSTRATED SCIENTIFIC NEWS.

I herewith forward my idea for a solution of the problem on "Regulating Balloons," according to the conditions published in your paper, and I agree to comply with those conditions.

Full Name .....

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The present month should be a good opportunity for sending subscriptions for the year's issue of the "Illustrated Scientific News."

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The Prevention of Enteric.

TYPHOID "VACCINE."

DISEASE kills many more men in war than the enemy's bullets; and the disease which has proved most fatal in recent wars, in the Soudan, as well as in South Africa, has been enteric. But apart from the abnormal losses caused by the conditions of warfare, like the losses which resulted in the epidemic at Bloemfontein, the British Army annually suffers a loss from enteric equivalent to nearly three battalions. Typhoid, or enteric, is caused not only by bad water, which was the preponderating cause on the march from Jacobsdaal to Bloemfontein, and to which the condition of the water taken from the river below Paardeberg no doubt contributed, but is also carried by dust, and is conveyed by flies. According to General Colville the precautions taken by the staff officers of the Ninth Division in the direction of boiling water before drinking it, did not confer immunity upon all of them, or upon even the majority of them. That, of course, may be an unscientific statement, in the sense that the water may have been boiled spasmodically, or that typhoid infected water may have contaminated the food. Still, it is certain that alike in war, as in peace manœuvres, enteric must break out; and there the greatest need is felt for some system of preventing enteric, or minimising its effects by some remedy of bacteriology.

South Africa.

In the South African War, after the outbreak of enteric at Bloemfontein, men were inoculated with what we may call "typhoid-vaccine" in feverish haste and in enormous numbers. Altogether four-hundred thousand capsules of vaccine were sent out to transports and to hospitals. But many of these "doses" were injected in an improper way, at improper times, and possibly on improper subjects. Consequently, so far as any question of revealing how far typhoid or enteric vaccination is effective goes, the experiments were largely negative, though on the whole it is claimed that the results of such vaccination were promising. But what is wanted is scientifically-conducted experiment at a time such as the present, when experiments can be conducted carefully and without haste all over the Empire and at every foreign station.

Experiments.

The use of typhoid vaccine is still in an experimental stage. The capsules containing the dose are manufactured at the Army Pathological Laboratory; and the effect of them must be ascertained chiefly by reports sent by the medical officers who try them. Some experiments are made upon medical officers who are passing through the course of instruction at the laboratory, and who offer themselves as subjects for typhoid tests. There is but one source of typhoid vaccine, and it is the Government laboratory. No charge is made for it, because, although its use—or its efficacy—is a matter which concerns everybody, it is rightly thought that its manufacture should not be encouraged among firms who would make it and sell it for a profit. At present no firm of chemists will make typhoid vaccine because they could not compete with the Government laboratory, which will supply it free to any properly qualified medical man. Further experiments must be made with typhoid vaccine—they ought in fact be made all over the world—to determine what is its value, its use, and the circumstances under which it should be used. For seven years, the experiments to determine what is the proper dose, what resistant powers it produces in the blood, and how it should vary with the patient, and the patient's condition, have been made with a minuteness and a careful particularity, which would be incredible in anyone unversed in scientific methods. The inquiries, though they have been productive of enormously useful results, are going on, and will continue to go on. A very much wider constituency of experiments and bodies on which to experiment is needed in order to establish the efficacy of the method on an indestructible and permanent foundation.

Manufacture.

A few details of its manufacture may help to show why it could not, or should not, be manufactured in bulk for sale by unauthorised firms. The method of preparation is roughly as follows:—Into a closed flask of beef tea a certain number of typhoid bacilli are introduced. In the beef tea they thrive and multiply, until there are billions of them in the flask. Without disturbing the general contents of the flask, a portion of the liquid can be taken out and examined from time to time, and its population counted. We will not pause to describe the way in which bacilli are counted; but we may say that the standard solution of typhoid bacillus is reached when there are 1,000,000,000 (one thousand millions, or more than half the population of the world) typhoid bacilli to the cubic centimetre. When this population is reached the flask of beef froth—plus bacilli—is sterilised. That is to say, it is heated to a sufficient temperature to kill the typhoid bacilli. This temperature is about 60 deg. centigrade. The temperature is ascertained by paraffin thermometers which float in the broth, and is not allowed to be exceeded, for fear of destroying other substances—bacterial products—which may be in the broth. This solution is then drawn off from the flask and sealed in tiny tubes about the length of a J-nib and the thickness of a slate pencil. This little sealed tube with its dead typhoid bacilli constitutes what we may call the standard dose of the standard solution of typhoid vaccine. If anyone should now ask: How is it known that this is the standard dose?—they will have hit upon the reason why at present "typhoid vaccine" must remain as a manufacture in the hands of the Army Pathological Department and its director. It can only be ascertained that this or that is the standard dose for inoculation or re-inoculation by experiments upon living subjects. When the blood is inoculated with "typhoid vaccine" it immediately begins to manufacture antidotes or anti-bodies, as the bacteriologists call them, to the typoid bacillus. It not only manufactures them in sufficient numbers to counteract the inoculated dose, but in numbers sufficient to remain over and be ready for any future attack by the typhoid bacillus, whether that objectionable beast comes in the form of a broth-culture or is taken into the intestines by drinking enteric-infected water or absorbing enteric-loaded dust.

Notable Articles in Recent Periodicals.

Mathematics in the Cambridge Locals. Professor J. Perry. *Nature*, Nov. 27.
Theory of the Gas Mantle. M. Solomon. *Nature*, Nov. 27.
Geographical Distribution of Fishes. G. A. Boulanger. *Nature*, Nov. 27.
Magnetic Focus in the Hebrides. Sir W. Wharton. *Nature*, Nov. 27.
West Indian Volcanic Eruptions. Professor J. Milne. *Nature*, Nov. 27.
Meteor Showers of 1902.—Professor A. S. Herschel. *Nature*, Dec. 4.
Sir W. Roberts-Austin, Life of. Dr. T. E. Thorpe. *Nature*, Dec. 4.
Physical Chemistry applied to Toxins. Dr. A. Harden. *Nature*, Dec. 4.
American Hemp Industry. Waldon Fawcett. *Scientific American*, Nov. 29.
Trials of Submarines. (Illustrated.) *Scientific American*, November 29.
Beechy Head Lighthouse. (Illustrated). *Scientific American*, Nov. 29.
Two Cycle Automobile Engines. E. W. Roberts. *Scientific American*, Nov. 29.
Mills Expenditure. W. W. Campbell. *Scientific American*, Nov. 29.
Protecting a Railroad from Flood Currents. (Illustrated.) D. A. Willey. *Scientific American*, Nov. 29.
Symbolism of the Huichol Indians. W. L. Beasley. *Scientific American*, Nov. 29.
Langley's Aërodrome. (Illustrated.) *Scientific American*, Dec. 6.
Utilization of Wastes and By-products. H. G. Kittredge. *Scientific American Supplement*, Nov. 29 and Dec 6.
Internal Flow in Centrifugal Pumps. (Illustrated.) J. A. Smith. *Scientific American Supplement*, Nov. 29.
Contact Process for the Manufacture of Sulphuric Acid. R. Knietsch. *Scientific American Supplement*, Nov. 29.
Apparatus for Sterilizing Water. (Illustrated.) *Scientific American Supplement*, Nov. 29.
Eruptions in the West Indies. (Illustrated.) *Knowledge*, December.
The Domestic Economy of the Thrush. A. H. Machel Cox. *Knowledge*, December.
Applied Optics. Chas. V. Drysdale. *British Optical Journal*, December.
Comets of 1903. J. B. Dale. *Knowledge*, December.
Comet Perrine. (Illustrated.) Catharine Stevens. *Knowledge*, December.
The Moon's Southern Horn. (Illustrated.) E. W. Maunder. *Knowledge*, December.
The Electric Motor and its Applications. *English Mechanic*, Dec. 5.
Niagara and Natural Water Power. *English Mechanic*, Dec. 12.
Nature of the Eruption of Mont Pelée. Dr. Ed. Divers. *Nature*, Dec. 11.
Reproduction of Colours by Photography. (Coloured Illustrated.) H. E. Dresser and Sir H. T. Wood. *Nature*, Dec. 11.
Fire-Walking in Fiji. (Illustrated.) *Nature*, Dec. 11.
Present State of Wireless Telegraphy. M. Solomon. *Nature*, Dec. 11.
Meteorology at Great Altitudes. A. L. Rotch. *Nature*, Dec. 11.
Tunnel du Simplon. Dr. Gustave Goegg. *J. Soc. Arts*, Nov. 28.
Photographic Development. Alfred Watkins. *J. Soc. Arts*, Dec. 5.
French Rural Education. Cloudesley Brereton. *J. Soc. Arts*, Dec. 12.
Water Tube Boilers (the Buttner). *Machine Market*, Dec. 4.
Alloys and Spiral Metals (the "Lion" Brand, S.A.M.) *Machine Market*, Dec. 4.
Electrical Machinery. ("Paragon" Motors.) *Machine Market*, Dec. 4.
Quarrying Slate. *Scientific American Supplement*, Dec. 6.
Python Swallowing Pig. (Illustrated.) *Scientific American Supplement*, Dec. 6.
Recent Discoveries in Crete. (Illustrated.) *Scientific American Supplement*, Dec. 6.
New Plant of Canadian Niagara Falls Company. *Scientific American*, Dec. 6.
Manufacture of Toys. (Illustrated.) *Scientific American*, Dec. 6.
New Monitor, "Wyoming. (Illustrated.) *Scientific American*, Dec. 6.
Guatemala's Earthquakes. (Illustrated.) *Scientific American*, Dec. 6.
An Experimental Mono Rail Line. (Illustrated.) *Scientific American*, Dec. 6.
Artificial Building Materials. *Stone Trades Journal*, December.
New Process of Brick Making. (Illustrated.) *Stone Trades Journal*, December.

Lectures to be delivered in January.

GEOGRAPHY.—Jan. 5, 4.30 p.m., Royal Geographical Society (Burlington Gardens)—Dr. A. J. Herbertson: "Landscapes in the Volcanic Districts of France."
Jan. 12.—Royal Geographical Society (Burlington Gardens)—Dr. Tempest Anderson: "The Volcanic Eruption in the West Indies."
Jan. 26.—Royal Geographical Society (Burlington Gardens)—R. B. Buckley: "Irrigation and Colonisation in British East Africa."
LOW TEMPERATURES.—Jan. 16, 8 p.m., Royal Institution (Albemarle Street)—Prof. Dewar: "Low Temperature Investigations."
METRIC SYSTEM.—Jan. 22, 8 p.m., Institute of Electrical Engineers. (Institute of Civil Engineers, Great George St.)—Discussion on "The Metric System."
Date unfixed. Wednesday, 8 p.m., Society of Arts (John Street, Adelphi)—A. Sonnenschein: "The Metric System."
MEANS OF DEFENCE IN ANIMALS.—January 7, 5 p.m., Society of Arts (John Street, Adelphi)—Prof. E. B. Poulton: "Means of Defence in the Struggle for Life among Animals." (Lecture II.)

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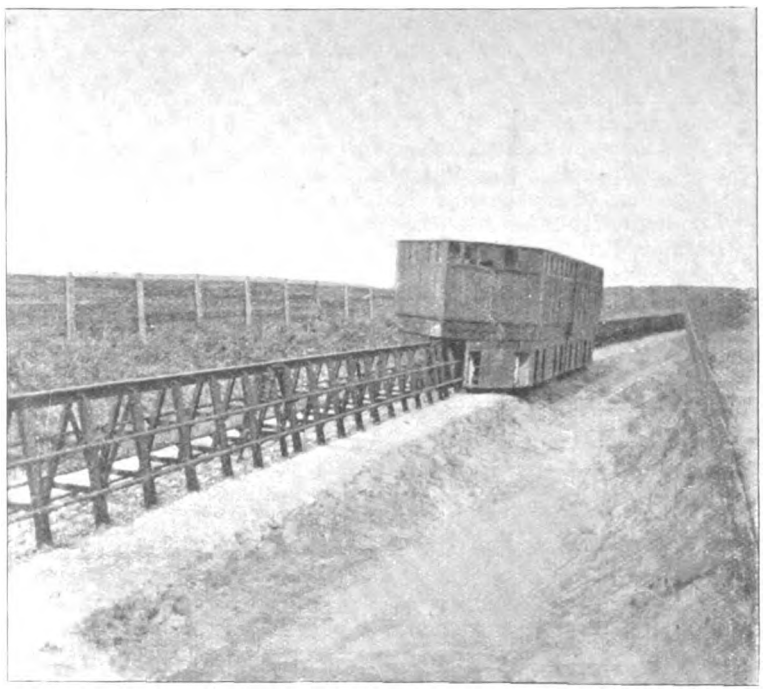


The Behr Mono-Rail System.
(2) *A Mono-Rail Car in position.*

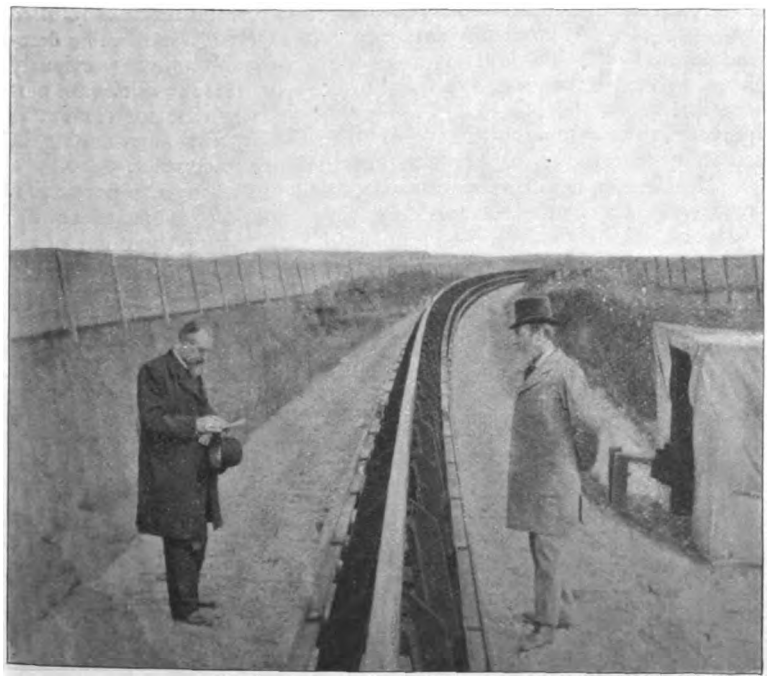
London to Brighton by Electric Railway.

RIVAL PROJECTS BEFORE PARLIAMENT.

(From a Correspondent.)

DURING the forthcoming Parliamentary Session no fewer than four Bills will be presented, in which powers will be sought to construct high speed electric railways between London and Brighton. These may be summarised as follows:—

1. The Cheesewright-Hammond Scheme.
2. The Behr Mono-Rail Scheme.
3. The Suspended Railway Scheme.
4. The Brighton Company's Scheme.



The Behr Mono-Rail System.
(1) *A Section of Mono-Rail.*

Mr. Cheesewright and Mr. Robert Hammond are the engineers of the "Brighton Electric Railway (Preliminary) Syndicate." The London terminus of the line is to be at Waterloo instead of in Pimlico as was proposed in the former Bill promoted by Mr. Cheesewright. It is estimated that the capital required will not be more than £9,000,000 "including a profit to the Syndicate." The line will be 47 miles long, and the generating station is to be at Three Bridges, about midway between London and Brighton. The speed proposed is about 75 miles an hour. It is proposed to run four trains an hour, two of them express, taking 40 minutes to do the journey, and two of them stopping at Croydon, Redhill, Horley, and Hayward's Heath, taking 55 minutes. The usual train will be of five cars carrying about 400 passengers, and the fares will be 5s. 0d. first-class and 3s. 6d. third class. The net earnings are put at £690,000 per annum!

The railway passes Clapham, the Common being avoided, then Tooting Common, the L. B. and S. C. Railway being crossed about east of Norbury Station, continues from this point in a S.S.-E. direction, and reaches a position slightly to the east of Waddon Station on the L. B. and S. C. Railway, where the first station, *Croydon*, is situated. The railway runs on a short easy curve and then continues in a straight line south, leaving Purley on the west, passing Coulsdon and Alderstede Farm and Merstham, arriving at a point in Redhill where the second station, *Redhill*, will be erected. From Redhill the new electric line proceeds parallel with the L. B. and S. C. Railway to the junction of two roads on the east side of the railway close to Horley Station, and here will be the third station, *Horley*. Leaving Tinsley Green on the west, it proceeds under Worth Park and Forest, crosses the L. B. and S. C. Railway at Balcombe, close to Keraps Farm, until it reaches *Hayward's Heath*, where it is proposed to erect the fourth station. Application will be made to connect Lewes with the station. The new line, keeping to the west of the L. B. and S. C. Railway, will pass Burgess Hill and Clayton, and will then enter a tunnel. On nearing Brighton it will pass under the Dyke Road, ultimately reaching Queen Square, close to the Clock Tower, on the ground line. It will be seen that there are five stations not including the Waterloo terminus:

1, Croydon; 2, Redhill; 3, Horley; 4, Hayward's Heath; 5, Brighton.

We understand that Mono Railways were originally proposed from London to Brighton and from London to Dover, the engineers

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of the projects being Mr. F. B. Behr and Mr. R. Elliot-Cooper, the engineers of the Manchester and Liverpool Mono Railway.

In the original project there was to be a common London terminus. or at least adjacent termini in the Strand. The lines cross underneath the Thames in tunnel, and rise to the surface at a point near Westminster Bridge Road. Hence the lines run parallel to each other on viaduct as far as Clapham Park. At this point the Dover line will branch off in the direction of Chatham, while the Brighton line will continue straight on through Croydon, will enter Brighton through a district which is almost completely free of buildings, and will end with a station just at the back of the Bedford Hotel. The length of the proposed London to Brighton Mono Railway is about 49¾ miles, and the time taken is to be 25 minutes.

With regard to the London-Dover Mono Rail project, from the divergence at Clapham Park the line was to go to Chatham where there was to be a station at which the trains to and from Dover were to stop. From London, Chatham would be reached in 20 minutes, and Dover in 40 minutes. The London-Dover project has, we understand, been dropped. Mr. Behr hopes that a section of the Manchester and Liverpool Electric Express Mono Rail Railway in the neighbourhood of Warrington will be completed, and a train running on it at the full speed of 110 miles an hour, in June next, in order that it may be demonstrated to the Parliamentary Committees considering the Brighton proposal that the Mono Rail is a commercial success.

As to the Suspended Railway Project the promoters of which are the Continental Company for electrical enterprises of Nuremberg, the owners of the patents, it is proposed to construct a line from London to Brighton on the same principle as the one between Barmen, Elberfeld, and Vohwinkel in Germany. Great speeds are claimed to be attainable on this system, and it is suggested that a suspended track should be built over the ordinary ground track, thus avoiding the acquisition of much new land. The question of tunnels at once rises, and we do not know how it is proposed to surmount this difficulty. A suspended railway on the Langen system is also proposed between Antwerp and Brussels.

The Red Spot on Jupiter. What is it?

THE planet, Jupiter, with its mysterious vapoury markings moving at varying rates in a number of different parallel currents, has always been an object of great interest. Its huge red spot, computed to be 7,000 miles across, was first noticed some 24 years ago. It rapidly increased in definition and depth of colouring, but later on it faded till, in 1892, it had almost disappeared. It then had a constantly-increasing retardation of motion, but

Mr. Denning, writing to "Nature," states that he has recently noticed that it has now a very pronounced acceleration of motion. In 1901 its period of rotation began to decline, and this acceleration of motion has been intensified during the past summer. About the same time there was an outbreak of "a large, irregular or multiple marking of a dusky hue" in the same latitude of the planet, having a rotation period corresponding to that of the south temperate current. The red spot has always been situated in a stream flowing with a much greater velocity than that of its own motion, which makes its presence very difficult of explanation. One of the most remarkable episodes of its career was when, in 1890, Mr. Stanley Williams noted a dark spot moving along the same parallel at a greater rate. This was watched with the greatest interest to see what would happen when it encountered the great red spot, but it was a surprise to all observers when it was seen to evade the latter by skirting round its southern edge.

Electric Power from Tides.

A SCHEME is being proposed by which electric power should be obtained from the tide at Dundee; and some optimistic calculations have been made as to the profits resulting from such a scheme. But as Mr. James Swinburne recently observed to the Electrical Engineers, all these schemes usually came to little on account of the great capital expenditure on turbines; and though many plans have been proposed for utilising the tides, few of them get past the theoretical stage. There is a tidal scheme in operation at Plonmanach, on the North Coast of France, and in this region there is a difference of tide level of about 20 ft. and it natural pond triangular in shape, with its base towards the shore—△—is separated from the sea by an embankment. In the embankment are automatically operated gates, which, owing to the angle at which they are placed, open when the level of the tide exceeds the height of water in the pond, while they are closed by the weight of the water of the pond when the tide recedes. This head of water is utilised to turn two water wheels, which in their turn operate dynamos. The current generated is used for lighting purposes. A storage battery is also made use of for storing the surplus energy. This is the only tidal power scheme we know, and it is rather doubtful whether it is a financial success.

The Railway Fog Signal.

IN his recent Royal Institution lectures on "Locomotion," Professor Hale Shaw spoke of the high degree of efficacy to which the modern fog signal, or rather of the modern system of fog signalling, had been brought, and mentioned the instance of trains which ran at express speed from Liverpool to Manchester through fog, and which did not once stop or slacken, although the driver sometimes saw not a single semaphore signal between one terminus and the other. It is the detonating fog signal which at present holds the field—or rather holds the rail. Although there have been many inventions brought forward for use with the detonator, such as devices for replacing a spent signal automatically, it is extremely doubtful whether any of these will ever become popular, or even obtain the sanction of the Board of Trade. But while the detonating fog signal is the simplest and most effective form of signalling—by ear—there are many disadvantages attached to its use. To a certain extent they are dangerous to the fogman, being liable to explode if roughly handled, and there is always the fear of the possible failure of the composition through damp, though this can to a certain extent be obviated by frequent renewals of the stock of the ganger, foreman, or other person responsible for their keep.

Again, when one realises how many battalions of the gigantic army of railway men have to be called out in time of fog, in the cause of safety, and when it is pointed out that in addition to the 116,000 platelayers who form a large contingent of the fogmen employed there are also some 42,500 men, referred to in the annual wages bill for England and Wales as "not classified," who are employed as fog-signalmen, and that the wages paid to this great army amount to no less than £7,000,000, it will be seen that the fog-signalling problem is an expensive one, and that any mechanical arrangement which might dispense with the fogmen would, could it take practical form, be warmly welcomed. The fogman's lot is not a particularly happy one, though a considerate management provide for his comfort so far as it is in their power; and a hut with a fire, in addition to a warm overcoat and a regular meal of meat, bread, and tea or coffee is provided for him. The ordinary detonator, which is made in two sizes, the large for passenger and the smaller for goods traffic, is clipped to the rail by means of a clasp, and the explosion of one of these signals is (according to the standard adopted by English railways) a warning to stop the train immediately. If the first explosion is followed immediately by a second, the speed need only be slackened, but a sharp look out kept for the regular danger signals. Should a third be exploded at about 600 yards' distance from the first two, the train must be stopped immediately. These directions do not apply invariably.

A very large, perhaps the greatest, proportion of detonating fog signals are made by Messrs. James Pain and Sons at their Mitcham factory, and the process of manufacture presents many features of interest. The first stage of signal-making takes place in a shed where men are occupied in feeding, with strips of tin plate, a powerfull machine which stamps the tin with dazzling rapidity into the cases and covers, which are afterwards to be filled with the explosive mixture. From this stage they pass into another shop, where they are placed in rows in a kind of form or mould, while the strips of metal, which are to form the clips of the finished signals, are soldered on.

They are then transferred to the "danger sheds"—there are rows and rows of these isolated little buildings, each only just large enough to hold a couple of men—approached and connected by a narrow raised platform; and outside each shed hang a couple of ominous looking red buckets; the floors are carpeted with india-rubber, while the men who work in them wear shoes of the same material. It is in these "danger sheds" that the tin cases of the signals are filled with gunpowder, and the detonators placed in them. The detonators consist of small metal trees or stands, which have previously been painted to prevent oxidization, on which three fulminate percussion caps are placed. This ugly looking little instrument is placed in the centre of the signal, with the powder surrounding it, so that when the cover is placed on they are in contact.

Needless to say, the operations entailed in fitting the percussion caps on to their stands is carried on in a building far apart from the danger sheds, though there is not much danger of their exploding prematurely. When the fog signals have been filled, they are "hand closed," and afterwards hermetically sealed by means of red paint, and finally "machine closed."

The clumsy looking little red packages are now fog signals, important guarantees for the safety of the public in South African blizzards and Indian rain storms, as well as in the foggy depths of London and the smoky manufacturing towns of Great Britain.

A Powerful Flame.

THE oxyhydrogen blow-pipe is now quite out of date. Acetylene dissolved under pressure in acetone and fed with oxygen gives a jet of enormous calorific intensity. So great is the heat produced that it can be used for the autogenous welding of iron, and holes can be fused in iron plates. This should prove of the greatest use in many industries.

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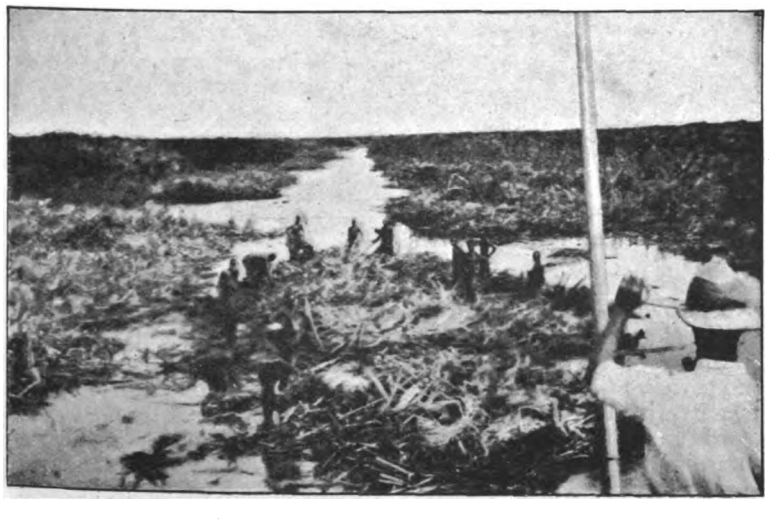
The Nile Sudd.

WEED BLOCKED RIVERS.

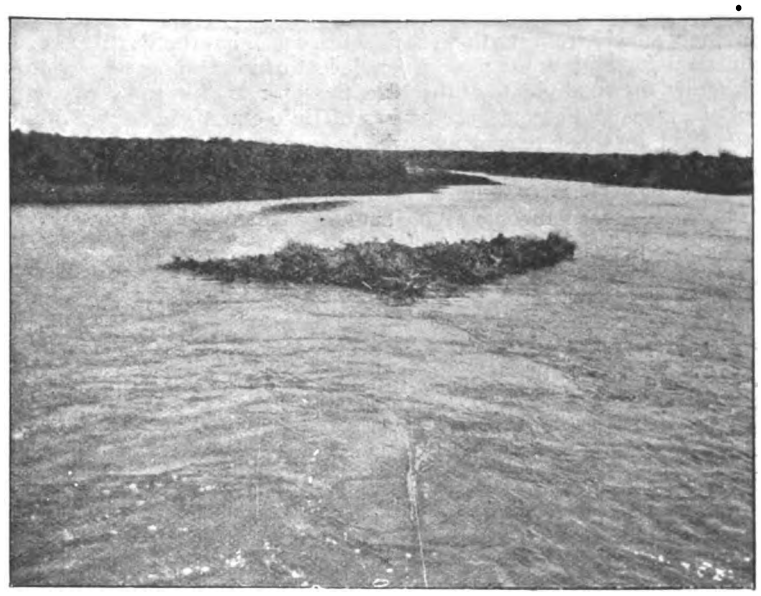
THE dams at Assouan and Assiout which have been described in a former number of the ILLUSTRATED SCIENTIFIC NEWS are only the first great step of the engineering works which may some day connect Egypt by way of the Nile to Central Africa and the Great Lakes. Before, however any other steps are taken by engineers to further navigation at the Nile Cataracts, it will be necessary to deal with the natural dams with which the Upper Nile is blocked, and which are often so effectual that the waters of the river spill over its banks, and create over vast marshes a system of irrigation, which is something worse than unproductive. These natural dams are monstrous accumulations of river plants, which, when they agglomerate are called "Sudd" or "Sadd." The agglomeration begins in the Bahr-al-Jebel or Mountain Nile, about 435 miles south of Khartoum, and extends another 250 miles southwards. It may then be said to be about 750 miles from the great Equatorial Lakes which store the rainfall of the vast mid-African catchment basins, and despatch it

Nile Sudd.—Natives Cutting Sudd in the White Nile.

northwards by means of the Mountain Nile. Before 1863 the Mountain Nile and its Eastern branch, the Kir, were both navigable. But in that year the weed they brought down blocked the Nile below the point where the stream, reinforced by other waters from the west and north, becomes the White Nile. A way through the obstruction was cleared with great difficulty; but each year it grew worse; and when, in 1878, there was a very great deal of flood water the obstruction was brought farther down the Nile, making a score of blocks through which two years work was required to cut a way. Twenty dams of weed were formed between the Kir and the Bahr-al-Arab, and the obstruction to the stream has continued, sometimes worse and sometimes better, to the opening years of this century. Under the direction of Sir William Garstin a resolute effort is now being made to deal with it. Sir William Garstin, by the way, had a practical experience of the methods of the formation of the "sudd," for, in 1900, he was imprisoned for three days in the Gebal River, the sudd having burst in from the side lakes and lagoons, and blocked the channel down stream of the steamer.



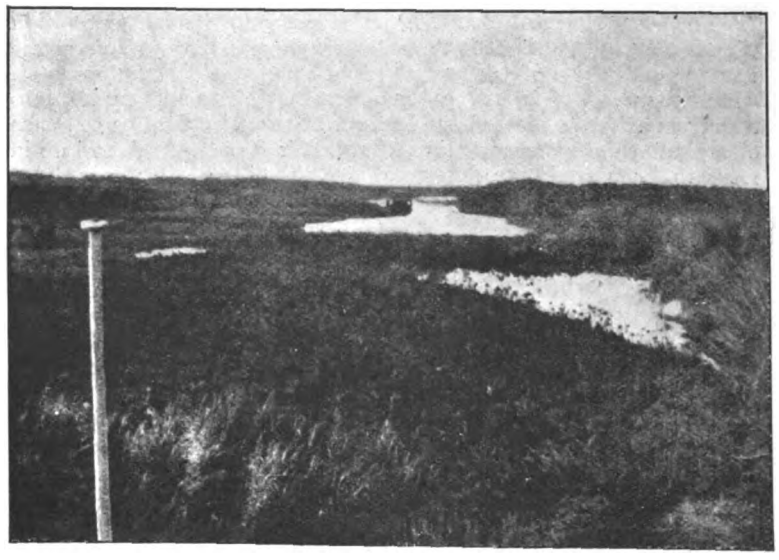
Towing Nile Sudd.



Floating Nile Sudd.

Papyrus, Um-soof, and Ambatch.

This monstrous obstruction, the extent and character of which may be gauged from the foregoing remarks and the accompanying photographs is due to the presence of three plants—the papyrus, the um-soof weeds, and the ambatch weeds (Sir W. Garstin assigns the blame to the first two, but the chief botanists of the Soudan give a prominent place to the share taken by the ambatch in obstructing the Nile in the performance of its duty). These plants have grown from small patches and fringes of river bank to thousands of floating acres of tough, dense, almost impermeable vegetation. The papyrus plant, which is honourably known as the basis of a writing material is the chief offender. It is now extinct in Lower Egypt, and was probably first introduced there from Nubia. But in the Upper Nile it is in a double sense in its element. In the Royal Botanic Gardens a specimen grows with stems nine to ten feet high; but it is more vigorous in the Bahr-al-Jebel. "On this morass," says an observer, "is a vast floating forest of papyrus and cane, perfectly dark inside. I never could penetrate more than three



A River Barrier of Sudd partially Cleared.

feet. Many of the stalks of the papyrus are as thick as my arm. The water percolates below and through the spongy mass, and there loses at least half its volume by absorption and evaporation. This impassable barrier is about a mile wide. The um-soof reed, and the ambatch reed, are hardly less important constituents, though for some time the ambatch has been exempted from blame because it is not found in great quantities in the Bahr-al-Jebel itself. It is a much more brittle reed than the shorter, tougher um-soof with its thick stems and broad sheaths from the nodes of the stem. One can easily imagine that the stems form a substantial woof in the entanglement of which the papyrus and um-soof form the warp; and the branches and twigs of the ambatch being thickly set with stout prickles like those of a rose plant would add to the trouble."

Sudd of Bengal Swamps.

In Bengal, water-plants of many sorts unite to form not only barriers in streams, but during the annual floods of the Ganges, Brahmaputra, and Surma Rivers, a dense mass of floating vegetation, extending perhaps 100 miles from east to west and as much from north to south. The main difference between the Bengal floating vegetation and the Nile sudd is that the Bengal sudd grows in wate

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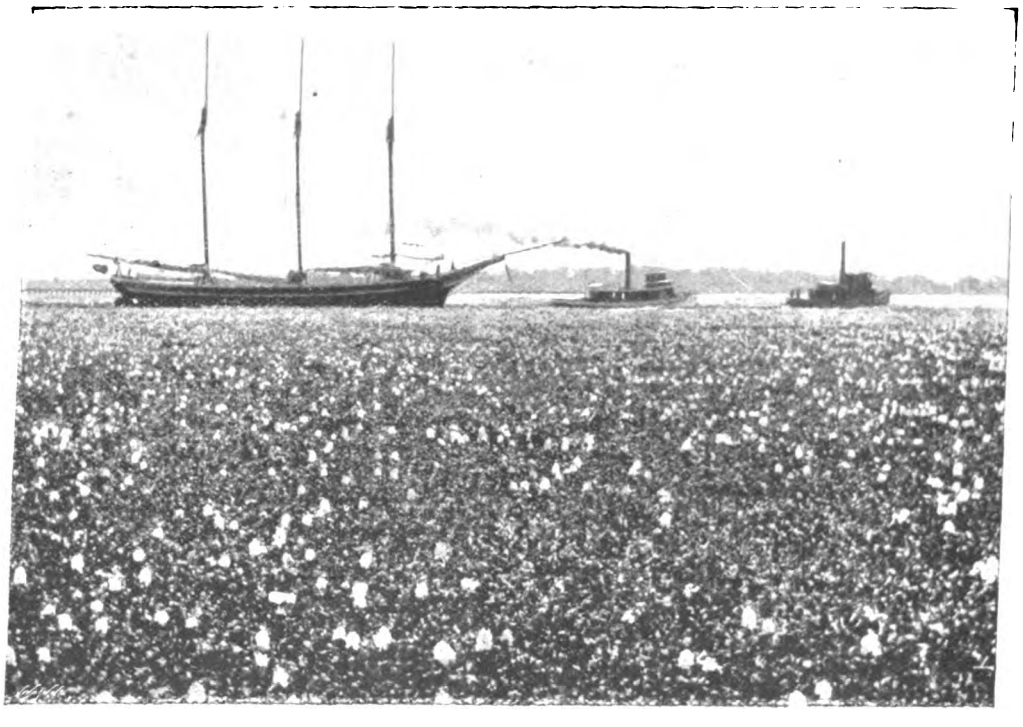
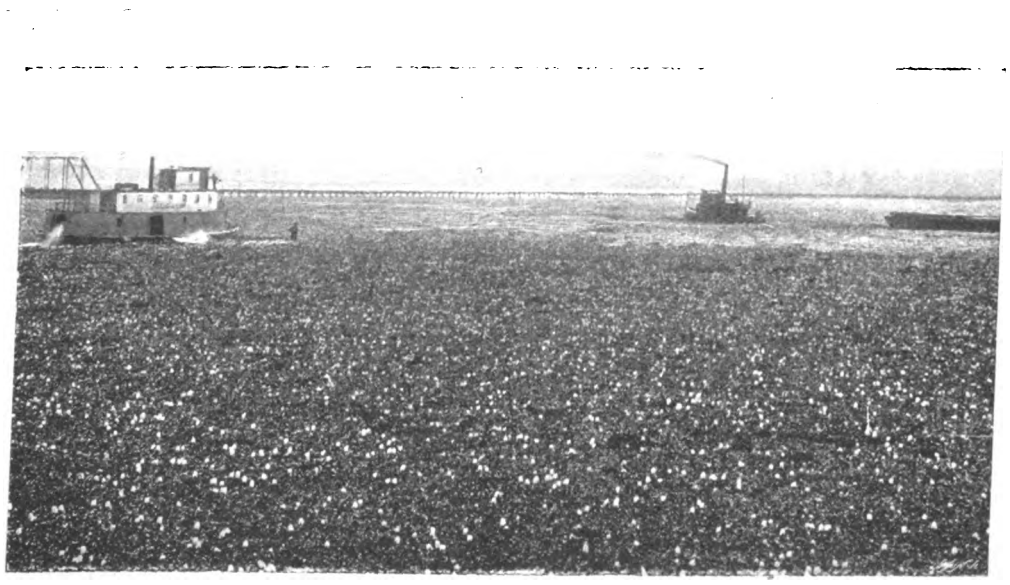
which is practically at rest (it really moves in mass though extremely slowly from north-west to south east), but the floating vegetation if forced into the main rivers is lost owing to their vast width; whereas the sudd plants of the Nile, though reared in the still waters of the lakes and lagoons are broken off into clumps and carried into the river by the strong winds which accompany the annual rise of the river, and thereby become potent for mischief. There is an interesting resemblance, however, between the plants of the Nile and Bengal sudds; and some of the smaller plants are identical.

Sudd in America.

The great rivers of South America carry no floating vegetation of sufficient bulk to impede their great volume; but in Guiana the river "sudd" is not unknown. Species of the Leguminosæ—of which the um-soof is a type—form dense thickets and extend into the rivers as far as they dare. In front of these is an advance guard of a plant called "mocca-mocca," which is, as it were, drawn up in rank to keep back the flood and growing in this water. This monster arum develops great club like stems which by and by assume the appearance of palisades ten to twelve feet in height. The floating island grass attaches itself and in the dry season the barriers will stretch right across the river—only, however, to be torn away in great masses as the floods come. Sometimes the barrier is strong enough to withstand the flood, though this is seldom, and then, since something has to go when a river rises sixteen to twenty feet in a night, the bank is carried away and the river takes a new bend. Many of the islands of the rivers of Guiana, some ten miles long, have in this or a similar way been built up of the flotsam and jetsam of river weed. The great floating masses ground on shallows and form nuclei for fresh deposits. Mr. Clarke, of Bengal, mentions by the way, a curious instance of a rhinocerous having been entrapped on a floating island of weed, and of its being carried down to Chittagong and sent to the London Zoological Gardens. An instance of obstruction by aquatic vegetation even more curious than those we have quoted is found in Florida, where someone introduced the so-called Water Hyacinth a few years ago. This pretty plant with spikes of light blue or violet flowers—which may be seen in the tanks at Kew—has been widely cultivated as an ornament of fresh water streams, lakes, and ponds. It took so kindly to Florida, that there is a serious apprehension that the St. John's River will be closed by it. The main channel of the river can just be kept clear, except when masses of the plant become so packed together as to produce a block. In a report published by the United States Board of Agriculture a photograph is given, showing the wide river quite covered by the hyacinth and large river steamers embedded in it. Masses of the plant floating down stream are banked up against a low railway bridge, or estuary, and form a dam across the river. Another photograph shows how the weed, floating down stream, has been diverted by booms into docks where it can be carted and used as manure. But though extremely troublesome, and, in fact, a picturesque curse, the water hyacinth is not nearly so serious a problem as that presented by the papyrus, the ambatch, and the um-soof—any possible benefit of which has yet to be found.



A Florida Sudd—A Ship being towed through a growth of Water Hyacinth.



Water Hyacinth Sudd—A block held up by a Railway Bridge—Steam Ferriers "held up."

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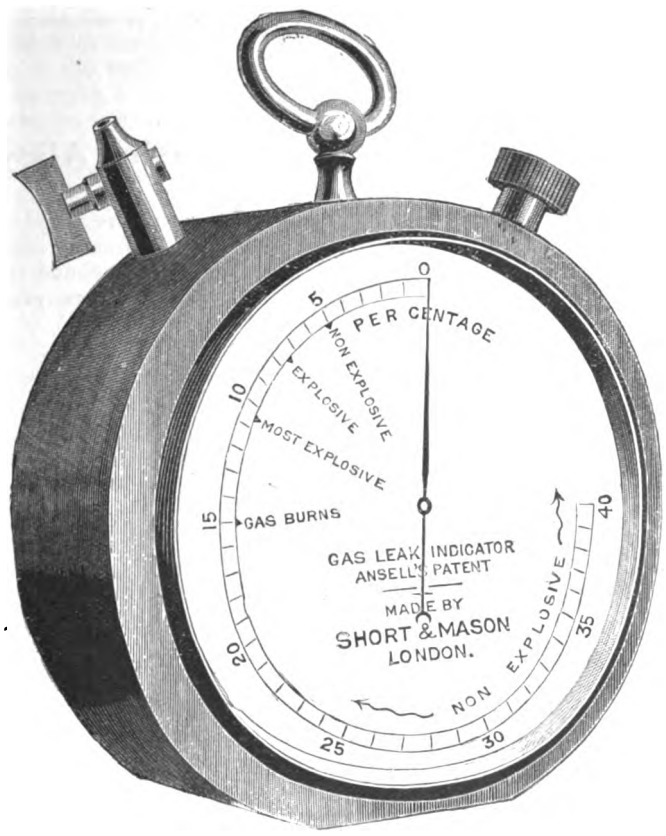
A Smell-Detecting Instrument.

OF the several forms of gas detectors suggested from time to time that which has been brought out by Messrs. Short and Mason, and of the dial of which an illustration is appended, has proved the most practical and useful. Its construction is based on the principle of the Diffusion of Gases, and the mechanical application of the principle is effected by the employment of an elastic metal chamber, the bottom being formed of a porous tile through which the diffusion takes place. When the "indicator" or "detector" is brought into an atmosphere charged with gas, the molecules of the gas diffuse



The Dial of the Gas Detector.

through the porous tile into the closed and elastic chamber with greater rapidity than the air of the chamber can pass out. Thus an increased volume and a consequent increased pressure are brought about: and the increased pressure on the elastic surface of the chamber sets a mechanism in motion which communicates with an index hand on the dial. The greatest effect of the gas is attained in two or three minutes, when the index hand ceases to move. The graduations on the dial denote the percentage of gas and the index shows the amount present.

An invention of similar purpose which has been patented in the United States has been adapted for use in warehouses and offices in such a form that it signals automatically the presence of gas. The three component parts of the invention are (*a*) bars or plates of a rare clay called sepiolite, which has the property of becoming heated when coal gas is brought into contact with it; (*b*) a thin platinum wire or combustible thread; and (*c*) a small battery connected up with an electric bell or some other signalling device. The plates of sepiolite are sandwiched with plates of spongy platinum. When there is a leak of gas the expansion of the plates either breaks the thread or expands the platinum wire—which can be made to connect with the battery circuit—and thus a signal is made. This invention has been combined with a smoke detector. A thread of horsehair or silk is boiled in a solution of soda and dried in a tube from which the air is exhausted. It now has the property of elongating when exposed to the action of smoke; and can be made to signal in a way similar to that already described.

New Sewage System.

THE Liernur Sewage System, which has just been installed at Stansted, Essex, has the advantage of insuring that all the drains are properly flushed, and that all injurious gases are carried off. The pipes from tanks in the houses are connected to central tanks, in which a vacuum is maintained by an air-pump. Every few hours the valves are opened and the sewage sucked from the house tanks at a considerable velocity, thus flushing the drains and drawing off all gases. Each set of house tanks is drawn off in turn, and the district tanks occasionally emptied, by a similar process, and the sewage taken to the works for treatment.

Nitrates from the Air.

IT has been suggested that the method of extracting nitrates from the air electrically by any such method as that described in last month's ILLUSTRATED SCIENTIFIC NEWS would dangerously exhaust the air of its nitrogen in the course of time; so that we should be fertilising the earth for plants at the expense of an important constituent of the air we breathe ourselves. Writing on this subject a correspondent of the *Chemical News* observes: "The atmosphere covering a square mile of the earth's surface would furnish sufficient nitrogen for ten years' supply of sodium nitrate at the rate of 12,000,000 tons of nitrates a year. To put it in another way—Had the fixation of nitrogen from the atmosphere by electrical synthesis and absorption been begun some 90 years before the beginning of the Christian Era and been continued up to the present time, with the same annual output of 12,000,000 tons of sodium nitrate, the effect on the atmosphere as a whole would have been so slight as not to show itself by the ordinary methods of gas analysis. In fact only a millionth of the available nitrogen would have been consumed. . . . Such a supposed deterioration of atmosphere, however, is founded on the assumption that nitrogen once fixed never finds its way back into the atmosphere . . . . the same general conclusions apply to oxygen. On the whole whole, therefore, the electrical process of producing nitrates is not likely to be a serious draft on the atmosphere."

The Rabbit Pest in Australia.

IT would seem as if almost every conceivable method had been tried to get rid of the swarms of rabbits which over-run certain districts of Australia, and render the land useless for pasture. Even the recent long drought, which has lasted practically for six years and which has caused such havoc among cattle and sheep, does not seem to have made any great difference, on the whole, in the number of rabbits.

Poisons of many different sorts have been tried without much success, and the introduction of infectious diseases has not been effectual, though under the auspices of Pastuer himself.

Trapping, even on a very large scale, has not succeeded in appreciably reducing the quantity. It is said that the chief reason of this is because the male rabbits get more easily caught than the female, and Mr. W. Rodier, in a recent pamphlet, shows that a large proportion of females always have a tendency to increase offspring. For this reason he suggests that, when caught, all male rabbits should be released, and then if they become greater in proportion, the females will fail to produce such large progeny, and the number of animals in consequence diminish. It is a well-known law of nature that polygamy is favourable, and polyandry unfavourable to the increase of offspring, and Mr. Rodier claims to have had considerable success on his station at Tambaa by adopting this method of killing off the females but sparing the males, and he urges the Government to test the system on a larger scale.

A Mosquito-Ridding Plant.

A SMALL plant growing on the West Coast of Africa, which possesses the valuable characteristic of driving away mosquitos from its neighbourhood, is described in *Nature*. It has been identified as being the *Ocimum viride*, a plant already known for its medicinal properties. Captain Larymore, the Resident of Kabba, obtained some of the plants near Lokoja, and kept them in pots about his house, finding them most useful for ridding the rooms of mosquitos, and enabling him to sleep unmolested without a mosquito-net. If this plant really possesses the properties claimed for it, it should prove a great boon to those living in tropical places, not only ridding them of a most irritating pest, but probably also preventing their liability to contract malarial fever. The plant should be cultivated and propagated. A similar characteristic is now attributed to the paw paw.

A Terrible Missile.

THE latest idea of an explosive shell will, if introduced, be a horrible innovation in war. This projectile has the greater part of its interior filled with lead, and when fired a burning composition melts this, so that when the shell bursts the molten lead is scattered to a considerable distance all round, and the smallest particle of it striking an opponent causes a nasty wound. A rain of molten lead would be worse than a hail of shrapnel bullets, especially considering that it would burn its way through clothes and headgear, and cause excruciating pain. Where is the Hague Conference?

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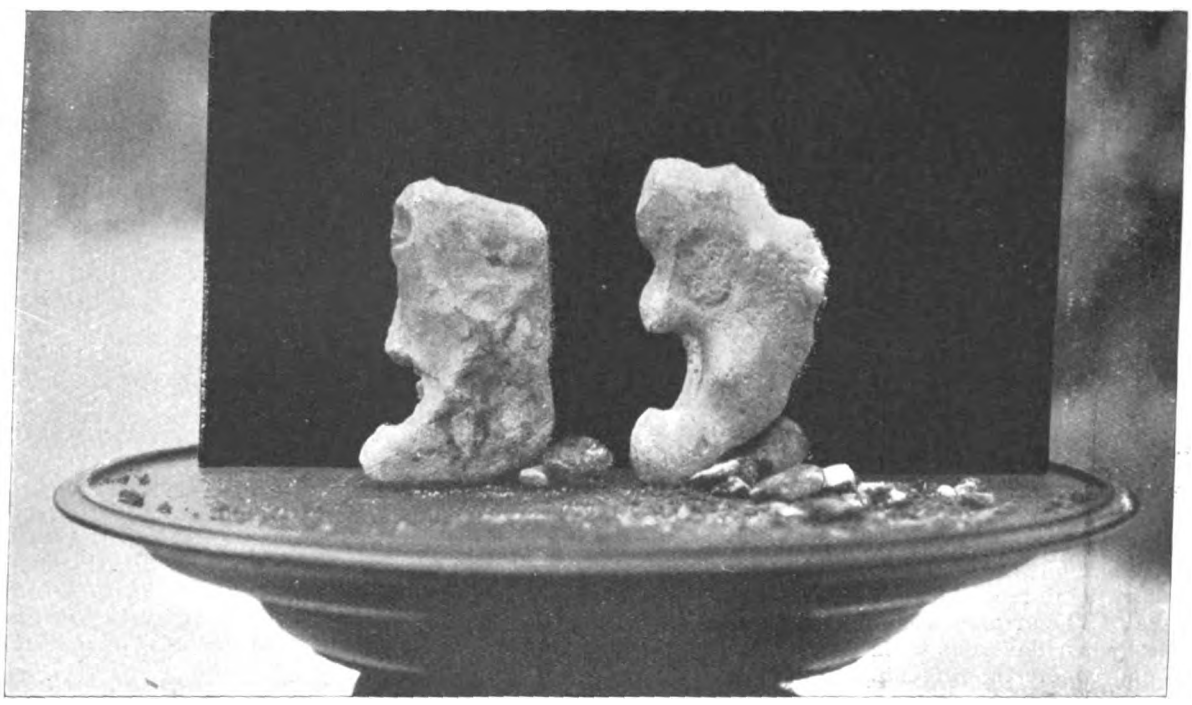
"The Earliest Human Likeness."

BY THE HON. AUBERON HERBERT, D.C.L.

Do the drift gravels contain only scrapers and implements used for hunting and for war; or did the same hand that fashioned these implements also fashion many other things—such things, as symbols of the sun and moon and stars, that we know have always so deeply impressed the early races, and representations of the animals, which played so large a part in the life of these races? That is the question we have to decide. When we remember the skill with which many of the palæolithic implements are fashioned, the perfect symmetry, and the faithful way in which the hand of the worker has followed his intention, it seems, I think, very unlikely that the masters of this difficult art of working in stone should have been content with their scrapers and implements, and not used their skill for other purposes. And remember also how many of the so-called uncivilised races—might we not call them nature-races?—have a gift for imitative and decorative work, reproducing forms, and combining colours with a skill that surprises us. Well, what is in itself unlikely did not actually take place, as we so often find is the case, when we carefully examine the facts. The evidence of the pits shows—as I contend—that these old workers employed the skill that they possessed for many purposes, besides making scrapers and implements. If I am right, the pits are full of worked stones, differing very much in the care and labour given to them, but all of them bearing witness, one to the other, of what the early mind was thinking and trying to say. In these pits we have a stone language, which the early races have left behind them, and by which they can in great measure become known to us. Let me take three great classes of their work as an example. First, the sun and moon stones. Of these there are large numbers—some roughly done, some done with care and skill. These stones have a little round cavity, sometimes one cavity, sometimes more. Sometimes there are two cavities placed close together; and one is puzzled to know if the stone represents the sun and moon, or the two human eyes, or is typical both of the eyes of the skies, and our own eyes. The moon-stones are however unmistakeable—the little delicate crescent being done with great skill and cleanness, and suggesting the use by the worker of some metal tool, or some special process. Then we find an immense number of animal forms—fishes, serpents, seals, and beasts, generally lying down. The work is often very slight, but often spirited and clever. A quaintly shaped flint—of which there are many—is chosen. In almost all cases a flat base is given for it to rest upon, unless it has little projections that serve for legs. [I may say here that in the pits you may at once recognise the hand of the worker by the flat base on which the worked stone is made to rest; and the eye when it gets accustomed to the pits will detect this flat base in great numbers.] A few spirited touches are then given to the stone, and life of a very simple but speaking kind is poured into it. It is impressionist work. The effect, such as it is, depends on two or three touches.

Then come the human likenesses. The greater number are very rough. A bold projecting nose in profile satisfies the artist. One would not know what the work meant, but for the few carefully worked examples, which explain the rough examples. In many cases the hair goes up to a point; in other cases the top of the head is quite flat, almost as if the top of it had been sliced off. The beard often comes well forward. These are profiles. There are also many full faces. The two eyes are given distinctly—the mouth to be found somewhere, but sometimes not without a little difficulty. They are very like a child's scrawl of a face, and the face suggests the monkey as much as the man. As you will see from the photograph sent the particular stone, about which I wrote to the *Times*, not only shows real skill in the working, but startles one by the high type of the features.



The Earliest Flint "Likenesses."

Magnalium: A Most Promising Alloy.

WHEN first aluminium was introduced as what we may call a commercial metal, a great deal was said in its favour as being so light, strong, and untarnishable. But it was soon found that it was not all that could be desired, since there were practical difficulties in working it. Various alloys were tried, but none of them proved to be much of an improvement on the pure metal, without much increasing the weight, until the alloy magnalium was discovered. This is obtained by combining a certain proportion of magnesium (from 2 to 30 per cent) with the aluminium. The result is a white metal like silver, capable of taking a high polish, which does not oxidise on exposure, being in this respect only surpassed by gold, silver, and platinum. It is actually lighter than pure aluminium, the specific gravity varying according to the proportions of the metals from 2·40 to 2·57, while that of aluminium is from 2·56 to 2·68 and magnesium, 1·7. The harder the alloy, which practically means the greater the proportion of magnesium, the lighter it is. The melting point of the alloy is between 640 and 676 deg. Centigrade, (or slightly higher than that of the pure metal).

It is a good conductor of heat and of electricity. As regards strength, its tenacity is nearly as good as wrought iron, being about 16 tons to the square inch. This alloy cuts and files well, and forges readily. It can be welded, and may be soldered with a special solder. It is most suitable for casting, and is formed into rods, sheets, tubes, and wire. Excellent screws can be cut in this material, so that it is particularly suitable for making telescopes and field glasses of. Owing to its lightness it should prove of great value to the experimenter with flying machines, and, if capable of withstanding the action of salt water, should be invaluable for yacht and boat fittings. As regards price, small quantities can be obtained at from 3s. a pound for ingots to 4s. for sheets and rods, tubes and wire being more. This is far cheaper than aluminium was ten years ago.

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On an Incandescence Electric Lamp which does not Blacken in Use.

BY DR. J. A. FLEMING, F.R.S.

EVERYONE knows that an ordinary carbon filament electric glow lamp gradually gives less and less light as its use continues. The time during which it lasts is called its "life," and the decay in illuminating power during its life is called its "ageing." If a lamp which has been long in use is examined it will be seen that the glass bulb is covered on the inside with a brownish film which cuts off a good deal of the light. This film is composed of particles of carbon which have been projected from the filament and have attached themselves to the inner surface of the bulb.

If we make a careful measurement of the "candle power" of a glow lamp in any direction when it is quite new and then continue to take observations at regular intervals during its life we shall find that the candle-power (c.p.) at first increases and then diminishes again. A curve delineating the c.p. in terms of the life of the lamp is called a *life c.p.* curve. The general form of this curve for a 16 c.p. Edison-Swan glow lamp is shown in Fig. 1. We can distinguish three stages in it. First, one which lasts about 50 hours from the beginning of its use, during which time the initial c.p. increases generally by about 10 to 15 per cent. Thus, a 16 c.p. lamp when worked at a perfectly constant electric pressure will generally increase to 17 or 18 c.p. in about 50 hours or less of use. The second stage lasts also from 50 to 100 hours, and during that time the augmented c.p. remains tolerably constant. During the third and subsequent period of its life the c.p. gradually decays, and it may finally come down to even half its original value before the filament breaks and the lamp ends its life. This initial rise and subsequent decay of c.p. is due to the operation of three causes. In the first place the initial rise is due to a gradual shrinking or consolidation of the material of which the filament is made such that its electrical resistance is reduced and hence the filament takes more current, and, therefore, gives more candle-power at a constant voltage or pressure.

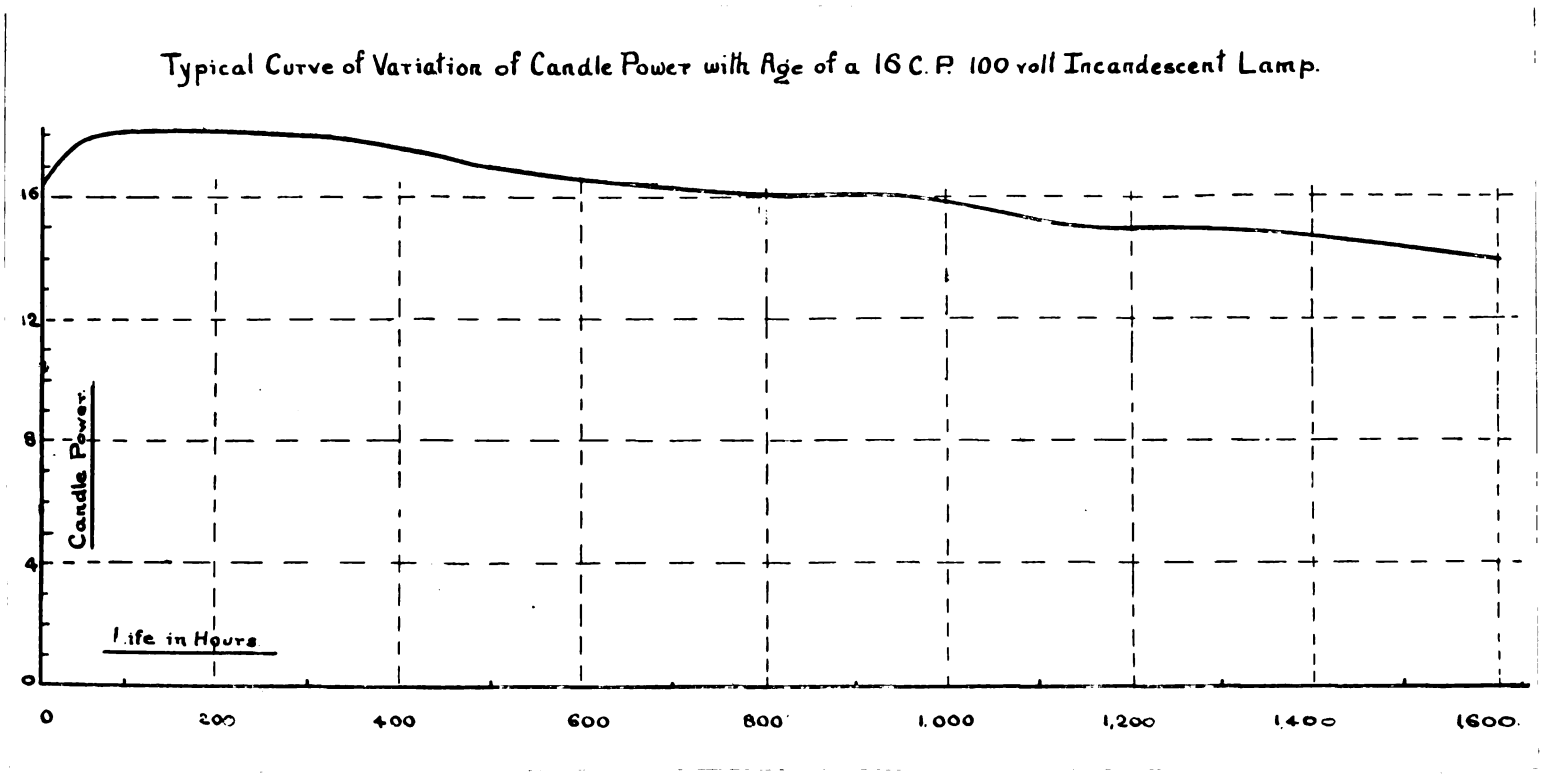

Fig. 1.

The subsequent decay in candle-power is due partly to a change in the surface of the filament by which it becomes a better radiator, and, therefore, has a lower temperature for a given expenditure of electric energy in it. The filament has put upon it in process of manufacture a deposit of carbon of a steely lustre. This is called the "treating," and a filament so made is called a treated filament.

If a carbon filament from a lamp with a treated filament which has been in use some time is examined under a microscope it will be seen that the treated surface is worn off in some places. The bright steely-looking coating of deposited carbon on a new filament forms a skin, covering a dull black carbon core which is called the primary carbon.

The deposited carbon, which has a metallic lustre, is a worse radiator than the dead black surface of the primary carbon upon which it is placed. Hence the treated carbon filament attains a higher temperature when in use than an untreated one of the same dimensions, for the same expenditure of energy in it. The lustrous carbon surface, like a bright metallic surface such as a silver teapot, is a worse radiator than a dead black sooty surface. Accordingly, on account partly of changes in the nature of the surface of the filament, the candle-power of a treated filament decays as the treated surface wears off. In the last place, the candle-power of the lamp decays because the carbon removed from the filaments clouds the inside of the bulb and obstructs the light. Hence the two operations of removing the deposited carbon from the filament and transferring it to the inner surface of the bulb both operate to reduce the light given by the lamp at a constant voltage.

Some years ago the writer had his attention drawn to the problem of constructing an incandescence lamp which should give such a constant light that it could be used as a standard of light when worked at a perfectly constant electric pressure. Many persons had previously endeavoured to use glow lamps as standards of light, but the above described causes of decay in light-giving power rendered a glow lamp of the ordinary form unsuitable for this purpose. The first matter to which the writer directed his attention was the prevention of the deposit of carbon upon the bulb. This was achieved as follows: It is well known to lamp makers that a glow lamp with a bad vacuum does not blacken when in use as quickly as a lamp with a good vacuum. But the lamp with the bad vacuum gets hotter and is less economical. The reason for the slower blackening in the case of the low vacuum is that the particles of carbon projected from the filament find greater difficulty in making their way amongst the greater crowd of residual air molecules. Hence the carbon molecules cannot so easily elbow their way towards the glass. The writer found by experiment that the same result, however, could be attained without the disadvantages of a bad vacuum by making the glass bulb very large. The carbon molecules have then farther to travel to reach to the glass and the chances of arriving at it without being eaten up by the way by active oxygen atoms and so reduced to the state of harmless carbon dioxide is considerably diminished. Moreover the greater area of the glass surface causes such carbon as does reach the glass to be spread out in a thinner layer, and, therefore, to be more transparent. Then, again, the changes which take place in the filament during the initial stage of its life can be brought about quickly by heating the filament electrically in a temporary bulb, and then transferring the filament to a permanent large bulb. Accordingly, about six years ago, the writer had some lamps made at the Edison-Swan factory on the following plan: Well treated and carefully selected carbon filaments were put into ordinary bulbs and run as lamps at about 5 per cent. above their usual working voltage for about 50 hours. Those which survived were then taken out of the small bulbs and put into large cylindrical bulbs about six inches in diameter and eight inches high (see Fig. 2A). The filaments were bent into the simple horseshoe or hairpin shape and not with double loop as in the ordinary lamp.

These filaments were 100 volt. 16 c.p. filaments, and after good exhaustion the bulbs were sealed and capped. The candle-power was then carefully measured against one of Mr. A. Vernon Harcourt's Pentane 10-candle standard lamps, the candle-power of the glow

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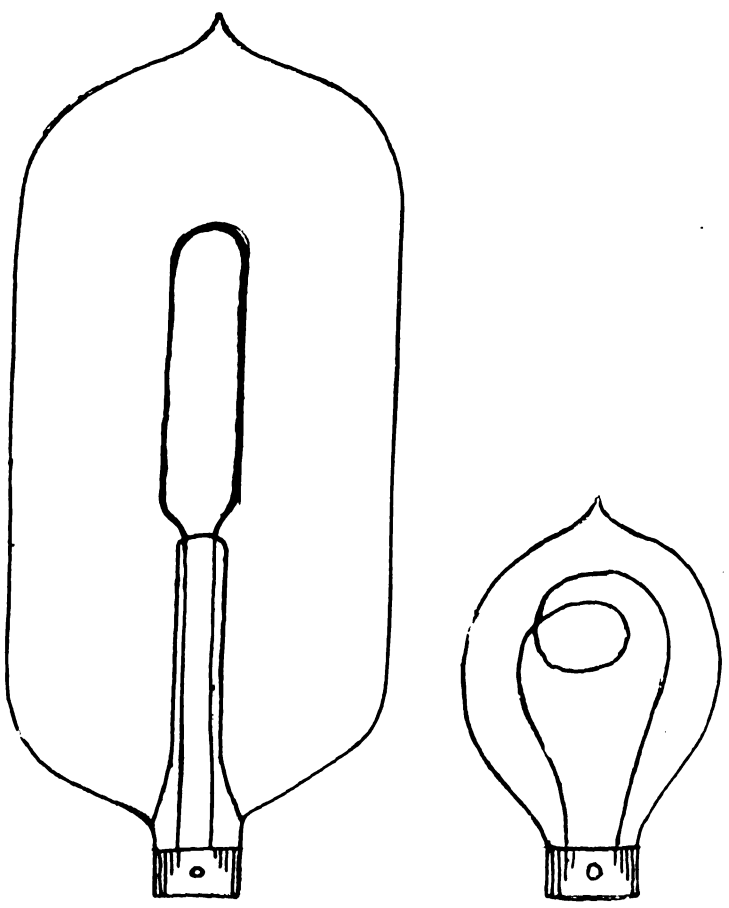
lamp being taken in a horizontal direction when the axis of the lamp was vertical and in a direction perpendicular to the plane of the filament. It was then found that these lamps with partly-aged filaments and large bulbs remained perfectly constant in light-giving power at a constant voltage provided their use did not extend in all for more than 50 or 100 hours. These lamps are not intended for ordinary continuous use but only as standard lamps by which to measure the candle-power of other ordinary lamps. For this purpose these large bulb lamps are admirably adapted. If the large bulb lamp is only in use for a few minutes at a time it may be used many hundreds of times without its use in all exceeding a few hours. A recent re-comparison of some of these large bulb lamps which have been in use in the Pender Electrical Laboratory of University College for six years as photometrical standards, with the Pentane Standard of the Edison-Swan lamp factory, showed that none of them had altered in candle-power by more than one per cent. on an average. These large bulb electric lamps when used as standards of candle-power have the great advantage compared with any flame standard such as the amyl acetate lamp or Pentane lamp, that their light-giving power is not affected by variations in the atmosphere. All flame standards are much affected by the presence of carbon-dioxide and water vapour in the air. The mere differences in atmospheric moisture of the air, according as the day is wet or dry, affect a flame standard lamp to the extent of several per cent., and standard candles and lamps of all kinds which depend upon combustion give less light when the air is vitiated by the presence of many people in the room. In the case of the standard large bulb glow lamps provided they are always used at the same electric pressure, there is no such variation.

These large bulb Fleming-Ediswan standard lamps are now being made for sale by the Edison-Swan United Electric Light Company as Standards of Light. Each lamp is marked with a certain voltage which must not be exceeded in working it. It also carries a mark



A. FIG. 2. B.

A. Fleming-Ediswan Large Bulb Standard Glow Lamp.
B. Ordinary 16-c.p. Glow Lamp.

showing the direction in which the lamp has a candle-power which is marked upon it when it is subjected to its marked voltage. The lamp should not be employed for more than a few minutes at a time to act as a means of comparison with other lamps. For this purpose a Lummer-Brodhun or else a Bunsen photometer may be used. The standard lamp is set at a distance from the photometer disc equal to the square root of its marked candle-power. Thus, for instance, if the standard lamp gives 16 c.p. at 100 volts., it is set at four feet from the photometer disc, and it then produces an illumination on it of one candle-foot. The lamp to be compared with it is then placed on the other side of the photometer disc and moved until a balance is obtained. The candle-power of the last lamp is then equal to the square of its distance in feet from the disc. Thus, if a given lamp placed at three feet from the disc balances the above 16 c.p. standard placed at four feet, the c.p. of the given lamp is nine in the direction in which it is being measured. It remains only to be said that a very accurate voltmeter, or better still, a potentiometer, must be used in setting the voltage of the standard lamp.

Electrical Notes.

FIRE ALARM TELEPHONES.

THE miserable fatality of the Queen Victoria Street fire has had one good effect at any rate in stimulating effort in the direction of equipping the Metropolitan Fire Brigade with scientific appliances. The latest reform is the adoption of the telephone, which will greatly facilitate the locating and control of fires. With few exceptions, all the fire-alarms in the London area have been fitted with telephonic communication with the nearest fire station, which the first fireman arriving on the spot can set in operation by means of a switch carried in his pocket. This will enable him to give information as to the location, nature, and extent of an outbreak to the fire station, which will then be in a better position to meet the situation.

MR. EDISON'S STORAGE CELL.

CHIEF of the reasons why the electric automobile makes less headway than its rivals of petrol and steam is that the storage cell, as generally manufactured, is heavy, is not completely trustworthy, and is expensive because of its rapid deterioration. Mr. Edison, whose latest form of storage battery was the subject of a signed article by him in the *Atlantic Monthly* a few months ago, in which high claims were made for it, is reported to be building five electric automobiles to run 5,000 miles each. They will all be equipped with his new battery, which it is the sanguine hope of Mr. Edison will enable a run of 100 miles to be made on one charge. A light run-about car is said to have recently covered 62 miles with a battery of 21 cells weighing 332 lb., and at the end of the trial the car still ran at 83 per cent. of its normal speed.

NIAGARA FALLS ELECTRIC POWER WORKS.

THE *Montreal Star* gives the following particulars of a test unique in the world's history:—Ever since power house No. 2 of the Niagara Falls Power Co. was commenced, the question as to the effect of passing 100,000 H.P. through the main tunnel has been the subject of discussion and computation. Now that units 11, 12, and 13 of 5,000 H.P. each have been completed in power house No. 2, and units 14, 15, and 16 have been so far completed that water could be passed through the wheel cases without the wheels, it was decided to make a practical test of passing the full quantity of water to be used in power house No. 2 through the tunnel, in addition to the full operation of power house No. 1, and of the paper mill. This was done Nov. 19, commencing about 10 o'clock and closing at 5.15 p.m., during which time a variety of hydraulic experiments were conducted to the end above referred to. At one time the paper mill, using 8,000 H.P., was, by the kindness of the company, shut down completely, so that the effect of this additional power could be observed. The results of the tests are said to have been entirely satisfactory, the tunnel discharging all the water used in a development of 100,000 H.P. The effect upon the low river by the doubling of the discharge through the tunnel was noted. The increased current impinged with considerable force upon the Canadian side, dividing the foam carried by the surface current, so that part of it passed up stream and part down. It is believed that this will aid rather than deter the formation of ice bridges by keeping the floating ice well up stream.

WILL WASH CLOTHES.

AN electrical washing machine has, according to the Buda-Pesth papers, been invented by Josef Nagy, of Szegedin. With this machine the use of soap is dispensed with, the electric current being intended to take away any stain or grease. This machine is said to be capable of washing as many as 200 or 300 pieces of linen without the assistance of a man being required.

A Bottle's Six Years' Cruise.

THE PORT ELIZABETH correspondent of the *Rand Daily Mail* relates the following curious story under date December 2 :—

A lime juice bottle covered with barnacles and containing three meteorological papers, viz., one for the *Nautical Magazine*, one for the Sydney Observatory, and the other for Mr. Wragge, the Queensland meteorologist, has been taken from the sea at Cape Receiffe.

The bottle, it appears, was thrown overboard from the Aberdeen ship *Patriarca*, on the 29th September, 1896, in latitude 40 deg. 8 minutes south; longitude 72 deg. 48 minutes east; and the papers are signed by Mark Breach, master of the vessel, which was then 77 days out from Antwerp. The position was S. 80 deg. W. from Cape Leeuwin, 2060 miles; and S. 81 deg. E. from Cape Receiffe, 2300 miles.

The nature of the Indian ocean currents would not allow the bottle to return to the westward, and it must have been carried east through Bass strait and around the Australian Continent by a counter current running northwards between Australia and New Zealand, then through Torres straits and into the tropics and westward across the Indian ocean until the current brought it down and landed it at Cape Receiffe, after a voyage of about 14,000 miles in 2252 days, averaging a steady progress of six miles for the bottle per day.

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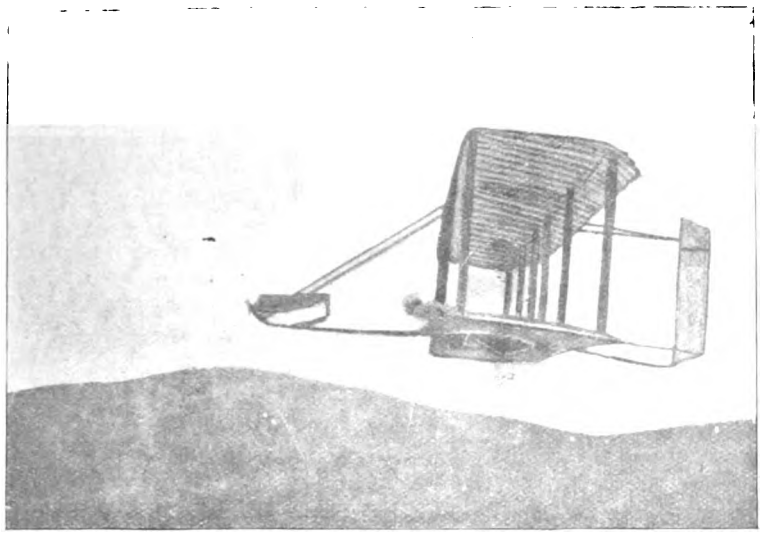
Gliding Machines.

The Latest Aëronautical Experiments.

BY O. CHANUTE, C.E.

MESSRS. WILBUR AND ORVILLE WRIGHT, of Dayton, Ohio, U.S.A., whose account of their experiments in gliding flight in 1901 created much interest, spent their vacation in 1902 in further experiments in the same direction. These were made, as before, on the coast of North Carolina, U.S.A., during September and October, and marked a great advance upon all previous performances.

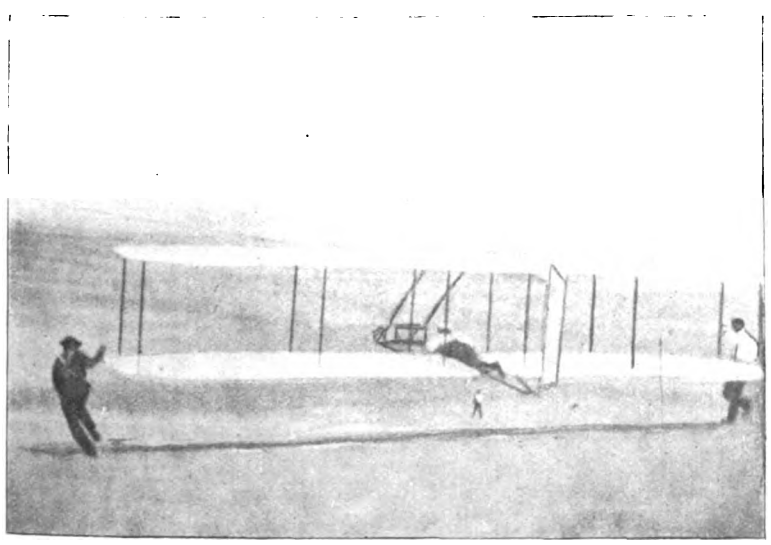
The apparatus this year was larger. It consisted of two superposed surfaces, each 32 feet from tip to tip, 5 feet in width, spreading 305 square feet of sustaining surface, and weighing 116½ pounds. It was equipped with a horizontal rudder at the front, and a vertical rudder at the rear, and it proved quite manageable; so that skill was



A Wright Machine—a side view.

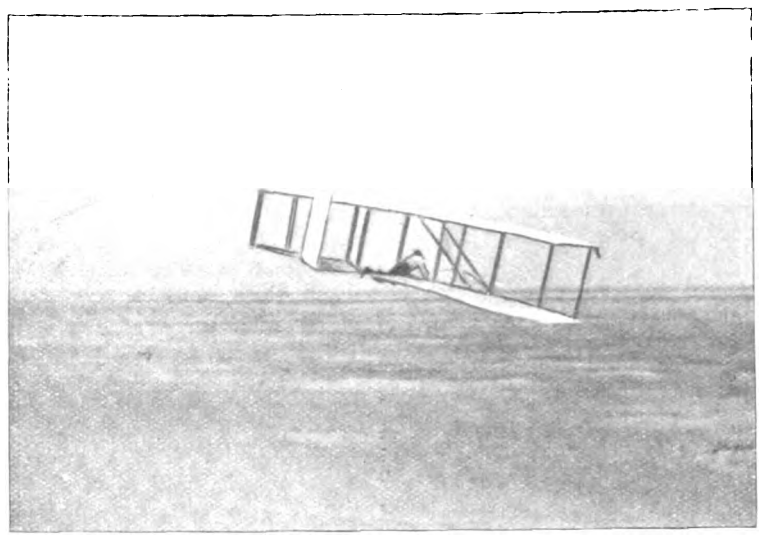
quickly acquired to steer it up or down or sideways, and to meet the irregularities and turmoils of the wind. The principal advance, however, consisted in the flatness of the angles of descent, these being almost invariably between 6 and 7 degrees, and in some instances as flat as 5 degrees, while those of previous experimenters were generally between 8 and 10 degrees. The Wrights now do nearly as well as the Buzzards, who are known by observation to glide downward in still air with a descent of 1 foot in 10, corresponding to an angle of 5° 45′. As a consequence of this flat angle of descent the weight sustained per horse-power shows a marked advance over previous achievements, it being about 120 pounds per net horse-power.

The method of conducting the experiments was the same as in 1901. The machine was taken upon a sand hill about 100 feet high, sloping at an angle of about 10°, two assistants, each grasping one corner, ran forward against the wind until a sustaining pressure was obtained, when they were told by the operator to "let go." The latter then guided himself with the front and rear rudders, warping also the wings when needed. He thus kept close to the ground and met all windgusts as they occurred, finally landing at the bottom of the hill by striking the sand at a flat angle and sliding thereon on the shoes attached to the machine.



Wright Gliding Machine—"Just let go."

No count was kept of the glides thus made, but they must have been over one thousand in number, all made without accident and with constantly increasing skill. The longest was about 600 feet. Records were kept of the speed of the glides, the trend and speed of



Wright Machine in flight.

the wind, and of the angles of incidence and of descent, to serve as a basis for computations, and it is understood that Messrs. Wright will prepare a paper, describing the results achieved for presentation to the Western Engineers' Society of Chicago.

Astronomical Notes for February, 1903.

The Sun.

THE Sun still remains in a rather quiescent state, but certain small outbursts of spots and faculæ recently observed give promise that the minimum sunspot period is now past, and the solar surface will again become an object of interest and attention on the part of the enthusiastic amateur.

Zodiacal Light.

The phenomenon of the zodiacal light (now generally conceived to be of solar origin) should, during the month of February, be looked for in the west after sunset. As there seems some misapprehension as to what constitutes a display of zodiacal light, it may be mentioned that it resembles the white ray thrown by an electric search-light, rather than the coloured glow seen after sunset.

The Moon.

The Moon (new on January 28th) reaches her first quarter on the 5th, becomes full on the 12th, the last quarter occurring on the 19th. She is new again on the 27th, and will be in perigee (or nearest the Earth) on the 10th, when she is distant but 224,000 miles, whilst when in apogee (furthest from the Earth) as she will be on the 22nd, her distance is 252,000 miles.

Observations of the Moon are best made about the first or last quarters, as far more detail is visible on the lunar surface at, or about, these periods than when she is quite full, besides which the blaze of light from the completely illuminated surface of our satellite is extremely trying to the eyesight when viewed through a telescope of even very moderate size and power. Crater formations are best seen when the Moon is between six and twelve days old, as they will then be observed becoming gradually illuminated by the Sun, whilst the surrounding valleys meanwhile remain in shadow.

No occultation by the Moon of any conspicuous star or planet occurs.

The Planets.

The number of planets suitably situated for observation in the evening hours in February is small indeed, comprising only Venus soon after sunset, and Mars for an hour or so before midnight.

The former is an "evening star," and not setting until nearly two hours after the Sun, should be easily observed as a brilliant object in the south-west. Her declination being north of that of the Sun will also tend to keep Venus clear of the strong twilight glow and haze which generally surround the region of the setting Sun.

The latter planet (Mars) is fairly well situated for observation in the constellation Virgo, rising at about 9 p.m. towards the close of the month, but his southern declination will militate against the discernment of detail on his surface.

Jupiter, Saturn, Uranus, and Neptune are all unfavourably situated for observation.

Mercury is technically a "morning star," reaching his greatest elongation (270 deg. West) on the 27th, but owing to his southern declination, and the fact that he rises but one hour before the Sun on the 26th (the most favourable occasion for his observation), it will require a keen vision to discern this little planet.

The minor planet Ceres comes into opposition on the 11th, and is, therefore, favourably placed for the observer throughout the month. On the 6th its North Declination will be 27 deg. 53 m. 45 s., and Right Ascension 10 h. 2 m. 17 s., the planetoid rising at 4 h. 5 m. p.m.

Constellations.

Looking southward at the beginning of the month, the brilliant constellation Orion is a conspicuous object, this fine group of stars coming to the meridian at about 8 p.m. Gemini with Castor and Pollux (The Twins) is just to the eastward of the same imaginary line, whilst the Greater and Less Dogs, with their two first magnitude stars—Sirius and Procyon respectively—are found to the south-eastward, having just recently risen.

Upon turning to the northward, the principal object which meets the eye is the well-known constellation of the Great Bear (Ursa Major), which, were we able to follow the whole of its course in the heavens by day as well as by night, we should discover never sets in the latitude of Great Britain. It is fairly well known that by drawing a line through Beta and Alpha Ursæ Majoris, we may, by extending the line to Ursa Minor, discover the Polar Star in the latter's tail.

During the month Perrine's Comet, which, it will be remembered, caused so much discussion last autumn, is due to return to visibility for a short period. A watch should, therefore, be kept for this object, especially on or about the 27th, when, according to calculation, it will be within about 3 deg. (or six "moon-breadths") north of the conspicuous star Sirius, and should, therefore, be easily picked up.

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Trans-Atlantic Wireless Telegraphy.

THE close of the year, 1902, will ever be a period to be remembered as one during which an important event in the annals of human progress has taken place, for distinct messages were then for the first time transmitted across the Atlantic Ocean without the use of any connecting wires. And yet this great achievement has not aroused such astonishment as we might have expected. It has been received with an apathy which can only be ascribed to certain rivals, who seem to do their best to belittle it. Whatever opponents may say, Mr. Marconi can now show that all he has for long foretold is an accomplished fact. If the letter " S " in the Morse code recorded on the instruments in Newfoundland in December, 1901, was ridiculed by some unbelievers as no proof of the possibility of transmitting messages, he now proves that he was correct in his surmises. Moreover, if wireless messages can to-day be sent clearly and rapidly across the vast space intervening between England and the United States, it appears more than probable that greater distances will be bridged, greater speeds attained, and more reliability ensured in the transmission of messages. It would be quite exceptional if such progress did not follow the introduction of the new system. When we consider the infancy of the invention, wireless telegraphy seems to have a very great future before it. Already, though only a few years old, it is a formidable rival to that great institution of such supreme importance to modern commerce, the submarine cable. In another few years—we will not be too optimistic in naming the period—it will, in all probability, oust such a cumbersome means of communication. In this connection it is useful to call to mind that the first submarine cable (about 1 mile long) was laid in 1842. Eight years afterwards the Channel was crossed, and in another eight years the first message was telegraphed across the Atlantic. What will the next eight years bring? Is it not *highly* probable the cables will then have to give way before the introduction of so simple a system? At all events it seems unlikely that capital will be sunk in the laying of new cables, for not only are they very expensive to construct and lay, but it has to be borne in mind that their cost increases in geometrical proportion to the distance. Thus with a cable capable of transmitting messages at a given speed over a certain distance, a certain area of section of copper (or other conductor) is necessary. To double this distance not only is double the length of cable required, but its sectional area must also be doubled throughout its length if the same rate is to be maintained. With wireless telegraphy, though a more powerful current must be used, and larger

Mr. GUGLIELMO MARCONI.

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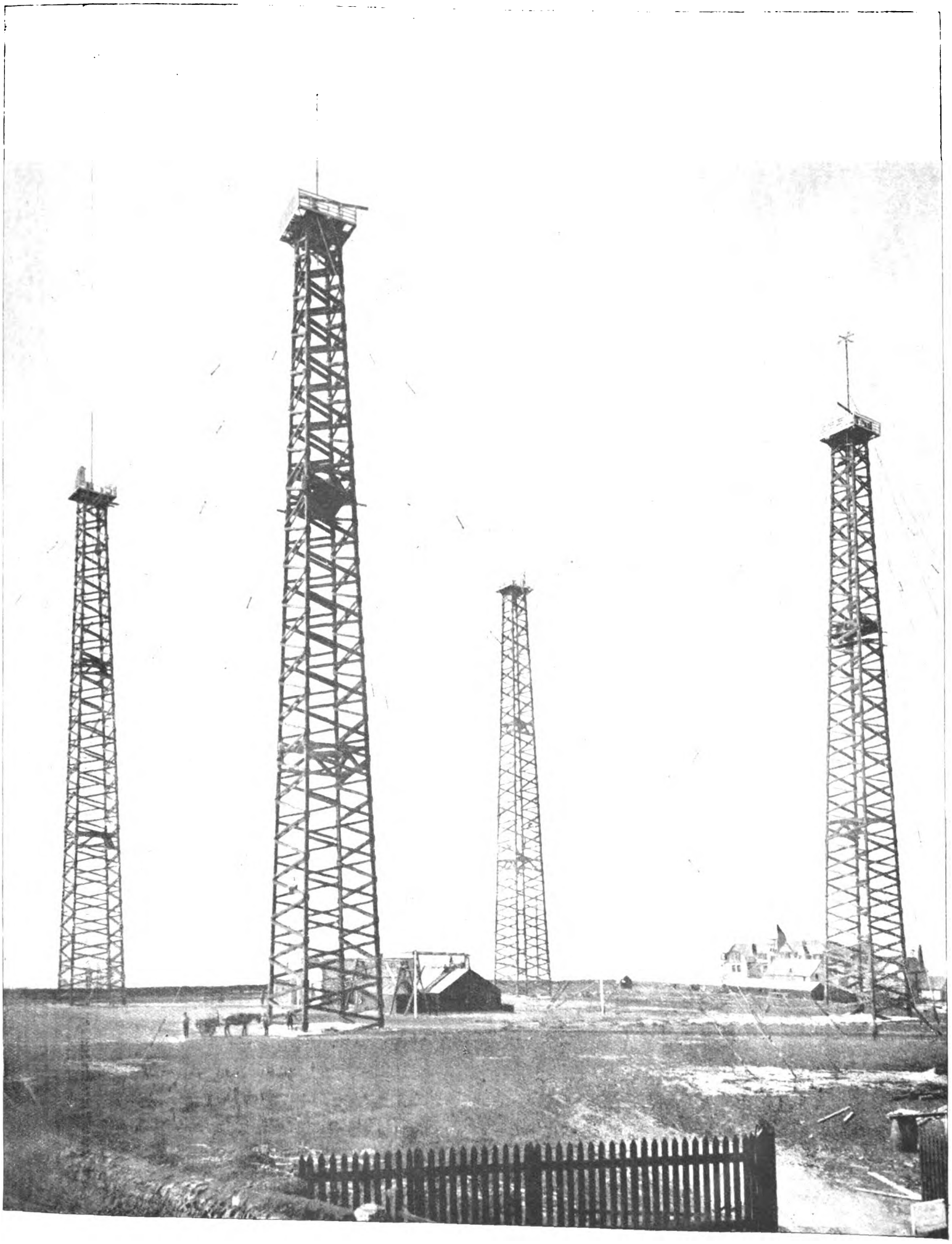

Marconi Station for Transatlantic Telegraphy at Poldhu, Cornwall.

The Towers support the Screens of Wires which receive the Signals

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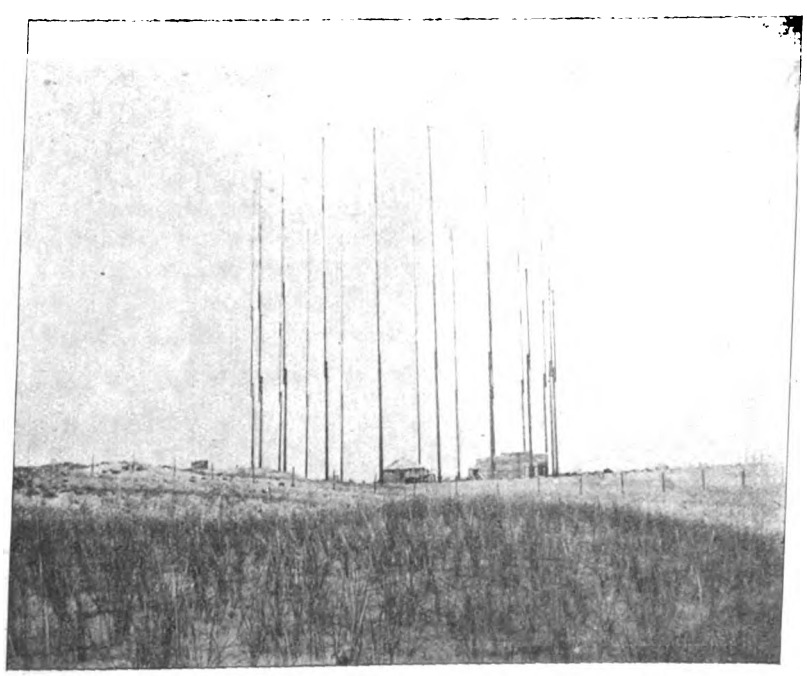
"antennæ" erected, they do not require to be augmented in this great proportion.

EARLY SCEPTICISM AND DOUBTS.

When it had been clearly demonstrated that Hertzian waves, se vibrating by the rapid charging and discharging of an electrical conductor, affected at a distance a "coherer," or pinch of metallic filings between the ends of two wires, and rendered it a conductor of the electrical current, the question naturally arose as to how great a space could intervene and this effect take place.

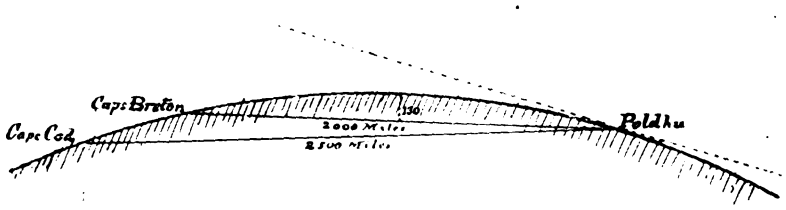


The first Receiving Station of the Wireless Telegraphy Signals. Recently blown down.

The taming of the Hertzian waves and putting them in harness for the service of man was one matter. This done, it had to be shown how they could be driven and applied to practical use. Marconi soon showed that by erecting a tall vertical wire, and charging and discharging this by sparks from an induction coil, the distance at which the coherer was affected could be greatly increased. When messages had been actually sent to a distance of 10 miles or so, there were many who considered that the limit had been reached. They argued that the power required would increase in so great a ratio as soon to exceed the bounds of practicability. Then it was found that hills to some extent at least interfered with the proper transmission of signals. So it was said that here again long-distance telegraphy would be rendered impossible. Then the curvature of the earth had to be taken into account. It seemed improbable, for various reasons, that the rays were sent out equally in all directions, through the earth as well as over its surface. If they only travelled on a horizontal plain at right angles to the upright wire, they would not follow the curvature of the earth, but would soon radiate into the upper regions of the air (as the dotted lines in the figure show).

Mr. Marconi with his Instruments.

Then Marconi got messages across the Channel and overland through 30 miles, and these achievements to some extent proved that the waves did follow round the surface of the sea, and were not altogether deflected or absorbed by intervening hills. At all events he himself was convinced and boldly asserted his conviction that he could telegraph across the Atlantic. If the etheric waves travelled in a direct line connecting the two transatlantic ports, they would pass through the earth 130 miles below the surface. The accompanying diagram will make this point clearer:



STUMBLING BLOCKS SURMOUNTED.

The completion of this great work of transmitting messages across the Atlantic has not been attained without the overcoming of a great number of obstacles. First it was necessary to erect a very tall wire, since it was found that the higher the wire of the transmitter, the further a message could be sent. This was eventually carried into effect by raising the wire into the air attached to a Baden-Powell kite. By this means the feeble signals of the letter "S" repeated at intervals, transmitted from the powerful station at Poldhu, were received in

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Canada. This was sufficient proof that it was actually possible to get a message across—that the Hertzian waves oscillated through such a distance, and that they were not precipitated horizontally off the surface of the earth. The next step then was to put up a vertical wire in a more stable manner than by suspending it from a kite supported by the fickle wind. A number of huge masts, 210 feet high, were placed round a circle and wires ran from their tops to the centre, but rude Boreas, who had often before disdained to support a kite, now blew in his fury, and wrecked again and again these artificial groves of lofty poles. The stations, both at Cape Cod and at Poldhu, were in turn wrecked before it became evident that some more substantial erection would be necessary for practical work. It must indeed have been exasperating to this sanguine inventor to hear again and again of these disasters, and to be confronted with such desperate practical difficulties.

THE WOODEN TOWERS.

This led to the erection of strong, trussed towers of woodwork. Four of them are built up at the corner of a square 70 yards apart, and supported by numerous stays. To construct them of steel might be detrimental to the efficient working of the apparatus. These towers are each no less than 215 feet high. They are connected by horizontal wires, from which depend a number of more or less vertical wires, connected to the apparatus below. It is hoped that these towers are sufficiently secure to withstand all winds they are likely to be exposed to. Already a gale of 70 miles an hour has been recorded at one of the stations without any damage having been done.

The distant transmission of signals appears to be dependent on three factors, power of the current, height of the aerial wire, and capacity. To obviate the difficulties inherent in a very high wire, Marconi has tried augmenting its capacity. He found that a metal cylinder surrounding the earth conductor acted satisfactorily. With cylinders only 4 feet high and 40 inches in diameter he was able to transmit signals over 30 miles under favourable circumstances. It was proposed at one time to build up a great metal cylinder, similar to a gasholder, but it is thought that the numerous wires of the present system are nearly as effective.

These great structures may, at first sight, appear to involve an enormous outlay, almost comparable to a cable. But the length of a trans-Atlantic cable is over ten million feet, or some 52,000 times the height of the towers! Besides, there is good reason for believing that even the existing towers are more numerous than is necessary.

There are now three Atlantic stations—one at Poldhu near the Land's End, Cornwall; the second at Glace Bay, Cape Breton, Nova Scotia; and the third at Cape Cod near Boston, U.S.A. All these are almost exactly alike in construction.

PRACTICAL WORKING-RATE PER MINUTE.

Detractors have been wont to say that wireless telegraphy can never compete with the cable owing to the inability to send messages at so great a speed. But there is no reason why it should be much slower than any other form of telegraphy, except that the form of coherer hitherto generally employed is not very delicate. All recent messages have, however, been sent by means of the "magnetic detector," a new invention of Marconi's. With this instrument the rate of transmission is entirely dependent on the ability of the operator at the receiving end to read quickly, since the message is received by sounds in a telephone and is not automatically recorded. With good operators messages can by this means be sent at the rate of 35 words a minute, a very fair speed even for a cable.

All the accessories are daily being improved, and with automatic sending and registering receivers, which will doubtless soon be introduced, the system should be worked at a much higher speed than that now attained.

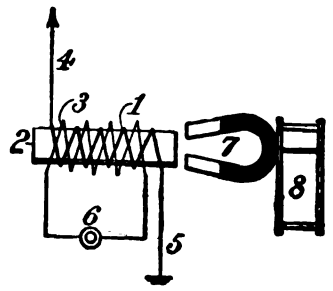
Then there is another improvement likely to be introduced. It has been found that at least two transmitting and receiving instruments can be attached to the same aerials, and send and receive messages at the same time. Possibly more could be used, differently tuned, and in this way the rate of transmission at one station doubled or trebled.

Though on the Newfoundland cables 70 words a minute have been attained, working duplex (a much higher rate than is possible with longer cables), after all it only implies that they can get through so much more work. It is a matter of indifference to the sender whether his message takes ten seconds or ten minutes to transmit. From a commercial point of view, the cable companies, charging double the rate and sending three or four times as many messages, should gain 6 to 8 times the gross receipts. But it is for practical experience to show whether or not the wireless system can be worked at such a fraction of the expense of the cable. The cost of the installation and erection of towers, &c., is said to be about one twentieth of that necessary to lay a cable. The upkeep of a cable is also a very serious item, whereas (unless the towers continue to get blown down) the Marconi apparatus should be very inexpensive to keep in order.

Cable companies once charged pounds per word, now they have got to shillings. Marconi starts with pence, and, without doubt, will be able to reduce his rates later on.

THE MAGNETIC DETECTOR.

It may be of interest to explain briefly the general construction of this Magnetic Detector, since it has only quite recently been introduced by Mr. Marconi. The aerial wires (4) are connected to a magnetic coil, surrounding a core of iron wires (2), and thence conducted to the earth (5). Over this coil a second fine wire is wound, its ends being connected to a telephone (6). At one end of, and close to the core is a permanent magnet (7) which is rotated by clockwork (8) so that the wire is continually being slowly magnetised and de-magnetised. When any oscillatory current passes through the inner coil a variation in the magnetisation takes place, which induces a current in the outer coil and thereby affects the telephone. Though at present this instrument can only be made to speak, as it were, into the operator's ear, doubtless in time it will be improved upon and the message be automatically recorded.



[From the *Scientific American*.

RELIABILITY AND SECRECY.

Doubt has often been expressed as to whether the existing system of wireless telegraphy is sufficiently reliable for practical purposes. It is true that atmospheric disturbances may and do interfere with the smooth working of the apparatus. In July last when the *Carlo Alberto* was in the Baltic, separated by 2000 kilometres of land and sea from Cornwall, messages were "broken by frequent atmospheric disturbances," but though it became impossible to receive with certainty by the coherer, the messages could be clearly read on the telephone of the detector. In fact, the magnetic detector is decidedly superior to the coherer for the detection of weak and distant signals. When we compare the receiving apparatus on board this ship to the huge erections for collecting the ether waves at the regular stations, it may be seen that such difficulties should be overcome.

Yet another objection raised against the wireless system is that the rays being sent out in all directions can be equally well read at stations not intended to receive the message. Thus any telegram dispatched from Poldhu could be read anywhere over the whole of Europe. But this may be overcome if the sending and receiving apparatus of each station be "tuned" or syntonized," so that no other station is affected by the waves so oscillated, and Marconi, who has proved true to his word in other matters, has said "the days of the non-tuned system are numbered," and, further, that "I am now prepared with syntonic apparatus suitable for commercial purposes." He has, too, other methods of so screening the waves as to make them unreadable in all except the desired direction. And, after all, this cannot be considered as any very serious obstacle to the practical working, since probably not one message in ten is really secret, and when it *is*, it would usually be sent in code. It would hardly be worth while anyone fixing up a station and keeping clerks at work solely with the object of tapping other people's messages on the off-chance of their being of value. And, after all, are even cable messages quite secure against being read by unscrupulous people to whom money is no object?

WHY IS THE WIRELESS SYSTEM DISCOUNTENANCED?

There can be no doubt that this great invention has not met with encouragement from the English people which it deserves. We need not go far to find a very good cause for this averseness. An enormous amount of capital is invested in submarine cables. Naturally all interested in such undertakings view with intense alarm the advent of a system which might sweep away their property. Naturally they will cast from them the hated night-mare, and will try to persuade themselves and their friends that it is a mere dream not to be seriously considered. This widespread feeling influences the public. It is true that the new invention may not be found to work as smoothly as its advocates hope. It may require radical improvement before it proves a commercial success. But it undoubtedly has a very great future before it. Whether the system be that of Marconi or of someone else we need not discuss, for the apparatus in use ten years hence will probably be very different from that of to-day.

Considering, however, the enormous advantages of doing without the miles and miles of most delicate and expensive cables, we venture to predict that some wireless method of long-distance telegraphy will soon entirely supersede the old-fashioned and cumbersome connections on which we have hitherto depended.

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The Hydraulic Mining Cartridge.

A SUBSTITUTE FOR EXPLOSIVES IN MINES.

THE Society of Arts has just presented to Mr. James Tonge, junr., of Westhoughton, Lancashire, their gold medal under the terms of the Benjamin Shaw Trust "for any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means."

The invention which has been fortunate enough to secure this important award is the patent of A. J. Tonge, J. Tonge, junr., and E. Eaves, and consists of a hydraulic mining cartridge which is intended to take the place of explosives for getting coal, rock, or other material.

It has long been recognised that the use of explosives in mines, especially in coal mines, is attended with great dangers and risks, and efforts have from time to time been made to introduce some mechanical substitute for blasting. Until the present invention, however, no apparatus had been found that could be looked upon as a practical working success. In the words of the committee to whom the duty of awarding the prize was entrusted by the Council of the Society:—"They are well aware that it has been frequently proposed to use some kind of hydraulic apparatus for this purpose, and they have had brought to their notice instances in which such apparatus has been successfully tried. They are not, however, aware of any hydraulic device similar to that of Mr. Tonge, nor that any hydraulic device has been brought into permanent or regular use for the purpose of coal mining, whereas they have had evidence that Mr. Tonge's hydraulic cartridge has been used with success in several mines where it has superseded the use of explosives. They have, therefore, awarded the prize to this invention."

Sir W. H. Preece, in making the presentation to Mr. Tonge, referred to the great importance of the invention to colliery working, and said that he believed the world would hear more of the revolution it would cause in this direction.

Besides the large catastrophes resulting from the use of explosives in coal mines, there are innumerable lesser accidents, attributable to this cause. It has been computed that from 20 to 25 per cent. of underground casualties are due to the employment of explosives, and that as many as 80 or 100 men lose their lives annually from such accidents, in addition to the larger disasters.

Description of the Invention.

The invention may be termed "the Hydraulic Mining Cartridge." The apparatus consists of the cartridge, the pump and stand (Fig. 1). The weight of the cartridge and pump is about 50 lbs. The cartridge, made of special steel, is 18 inches long and 3 inches diameter, and has eight small duplex rams fixed radially along it. A small hole $\frac{1}{8}$ inch in diameter runs nearly from end to end of the cartridge

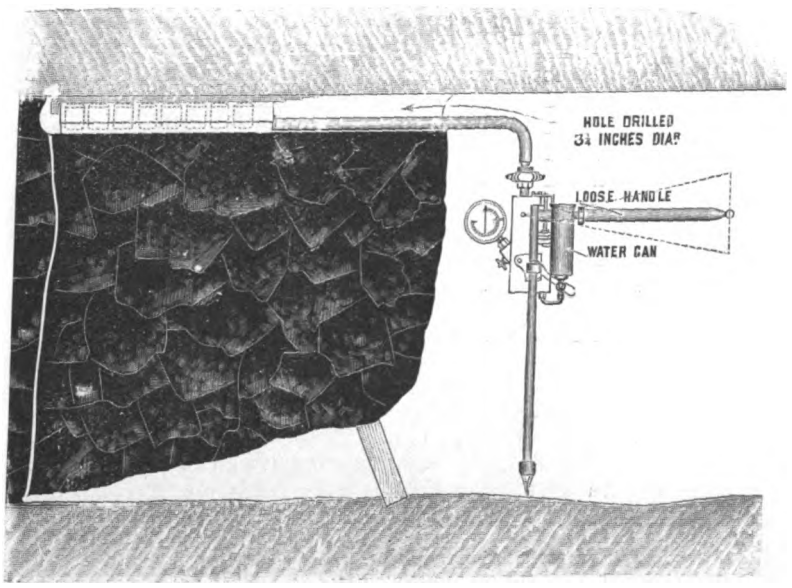

Fig. 1. Diagram showing Cartridge with Pump.

whereby communication is made between each of these rams, ensuring simultaneous action. Hydraulic pressure from the small pump forces the rams out of their chambers, and these after travelling a certain distance, by an ingenious arrangement in the rams themselves, telescope out, that is to say, one portion of the ram is stopped while another portion continues to travel. This travel is necessary for the complete forcing down of the coal.

A small pump is attached to the end of the tube, fixed on a stand, and readily adjusted. About a pint of water is required for each operation, and this is supplied from a small vessel attached to the pump, into which the water may be again emptied after doing its work in the cartridge. The pump and cartridge are first filled by using the small handle, but when the pressure comes on it is necessary to apply the longer handle shown in Fig. 2, in order to obtain greater leverage.

Mode of using.—In using the cartridge, the coal is first holed in the usual way, in all respects as it would be if an explosive were about to be used. A hole is then drilled as if for a shot, $3\frac{1}{4}$ inches in

Fig. 2. Cartridge Inserted: Coal being Broken down.

diameter, so as to admit of the cartridge 3 inches in diameter. The hole is drilled a little short of the undercut. When the holing has been done and the drill hole bored, the cartridge is inserted and is then pushed to the back of the hole, Fig. 1. No tamping or stemming is required (a frequent cause of accidents where explosives are used). The cartridge is simply pushed to the back of the hole and the stand fixed to the pump. The front of the coal is then secured by short holing props, so that when pressure comes on, the coal will not give way first in front.

The water is then pumped into the pipe and other spaces in the cartridge by the short handle, this occupying only a few seconds, the longer handle is then put on, and being worked, the pressure begins to come on, and at the same time a cracking sound is heard at the back, indicating that the coal is being cut or sheared off at the back of the hole, the front remaining quiet. The cracking sound gradually comes nearer the front and soon a long crack is noticed separating the coal from the roof. Pumping continues until it is thought that the whole weight of the coal is upon the props, the time of the full operation being five to six minutes. The hydraulic pressure is then released, the cartridge withdrawn, and the props being knocked out from under the coal, the whole mass comes safely to the floor (Fig. 3).

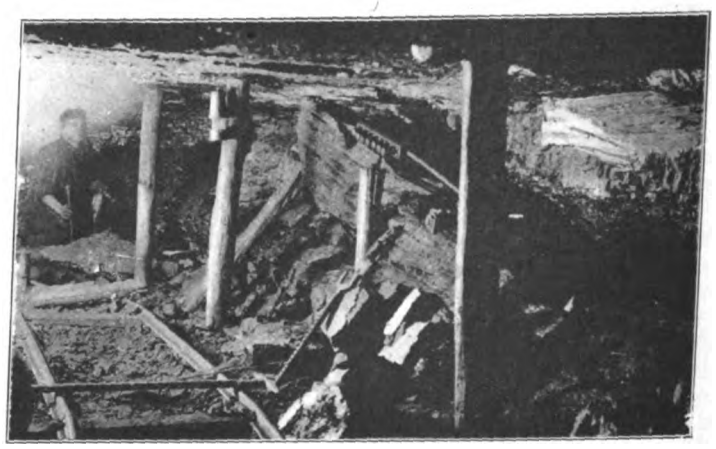

Fig. 3. Coal Broken down.

Advantages.—It will thus be seen that the following results are obtained by using an apparatus of this kind:—

1. Absolute immunity from explosions.
2. Coal can be brought down at all hours of the day, thus avoiding night work for such purposes.
3. No shaking of roof, and this in most cases is important.
4. No damage to doors, etc., from vibration of air owing to fast shots.
5. Least possible amount of dust.
6. Absence of poisonous fumes.
7. Dangers of "blown-out" and "missed" shots avoided.
8. Coal is larger when brought down, and is not shattered, consequently is not so readily broken in transit to the shaft and to the waggons.
9. The following comparison between the use of explosives and the hydraulic cartridge shows a distinct monetary gain to the employer.

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Actual Average Results over Six Months' Working in a Seam using Hydraulic Cartridges.

1.—INCREASED VALUE OF OUTPUT.

Output per day, 225 tons.

Percentage of "round" increased from 69 per cent. to 78 per cent. or 20½ tons (taken after screening and filling in waggons).

INCREASED VALUE of 20½ tons at 5s.—the difference in value between "round" coal and "slack"—for two hydraulic cartridges per day £5 1 3

2.—INCREASED ECONOMY OVER EXPLOSIVES.

Two cartridges used each 25 times replace 80 explosives shots.

	£	s.	d.
Cost of 80 shots at 4d.	1	6	8
Wages of 1 shot lighter	0	5	3
	£1	11	11
Wages of two men to work the 2 hydraulic machines ...	0	10	6
Value to the colliery of the 2 machines each day	1	1	5
Deduct for repairs and original outlay increased economy per day	0	6	5
	£0	15	0

Total Gain each Day for two Hydraulic Cartridges.

Increased value of coal	5	1	3
Increased economy over explosives	0	15	0
Total gain per day	£5	16	3

JAMES TONGE, Junr.

The Evolution of the Horse.

MORE than once in recent speeches and appeals for the help which all scientific education needs, it has been pointed out that the American millionaire is very much more generous to scientific institutions and scientific investigations than the rich man in England. What English millionaire, for instance, would do as Mr. C. Whitney has done in endowing a fund which is under the American Museum of Natural History for the exploration for fossil horses. In this way Mr. Whitney hoped that the evolution of the horse from its primeval ancestor might be determined. The investigators commissioned by the Museum have had a very good year. In the upper miocene deposits of Texas, several skulls and feet, as well as a complete skeleton, of the Anchitherium or three-toed horse were found. This was a horse which lived in marshes. A complete skeleton was also found of the Mesohippus Bairdi. The Montana expedition found a good example of the Mesohippus Westoni, the little known horse of the lower oligocene. In Nebraska were found the remains of a small herd of Hipparion. One skull, eight hind limbs and feet, four fore limbs and feet, one helix, and enough vertebrae to form a vertebrae column were unearthed. From these, a complete animal will be set up in the Museum. The horse of this species has feet of a very long, slender type, and narrow pointed phalanges.

Aims of Bacteriology.

The Newest Methods.

IN some remarks lately made by Sir William Church, President of the Royal College of Physicians, he said that the outlook of medicine had altogether changed in the last twenty years; and by this he meant in part that the rapid advance made in bacteriology had brought with it entirely new views of disease. There has been an overturning of old methods, and since the discoveries of Pettenkopfer whole chapters of the theory of preventive medicine have been written. Bacteriology has been a very hard fight. The conservatism of the medical profession—of all professions, except, perhaps, that of law, the most conservative—stood out for many years after Pasteur in France, and Tyndall in England, had killed the doctrine of spontaneous generation; and it is only in the last twenty years that experimental research has completely broken down the barriers that lay between the truths of bacteriology and their complete acceptation by medical men. Koch's research in connection with the tubercle bacillus may be spoken of as the classical example of the establishment of bacteriological methods on an unassailable foundation. He demonstrated finally the causal connection between the tubercle bacillus and phthisis and the allied diseases, and his demonstration may be crystallised in the phrase "No tuberculosis without the tubercle bacillus." It is only fair to point out that his conclusions could not have been reached without experiment on the lower animals—an argument in favour of vivisection of which most people will see the force. Let us now see what benefits to medical science and to the human race have sprung from these discoveries.

BACTERIOLOGICAL DIAGNOSIS.

The diagnosis of disease conditions—conditions which may be possibly due to infectious agents—has been rendered very much more accurate. By bacterial methods the suspicions of clinical diagnosis may be verified or disproved at a very early stage of the disease, and the disease can therefore be dealt with much more promptly. This is especially the case in tuberculosis. By bacteriological examination of the patient's sputum, the presence of tubercular infection can be detected before serious developments of the disease have set in; and we now know that not only is tuberculosis preventable, but that it is curable in its earlier stages, so that, if the disease can only be detected soon enough, there is no reason why the patient should not get better. Then, again, in typhoid the blood test—by which a sample of the patient's blood may be made to yield evidence whether the patient is suffering from typhoid or not—is a remarkable example of the delicacy of the bacterial methods. In this instance the mere presence of the typhoid bacillus in the blood is detected on admixture with a preparation of a laboratory typhoid colony—long before the usual symptoms of the disease have disclosed themselves. In the case of diphtheria, the diagnosis goes a step further, and the administration of a preparation of diphtheritic serum to the patient acts as an antidote to the disease, in the manner described in the January number of the ILLUSTRATED SCIENTIFIC NEWS.

THE STUDY OF THE BLOOD.

Some of the most interesting results of bacteriology are now being attained by an examination of the infective processes of the blood. In fact, we may say that bacteriologists, in studying the theory of immunity from disease, are at present concentrating their attention on the study of the blood, which in itself is the best physiological index of what is going on in the body, because it represents all the body's tissues and all the body's products. For the resistance of infections, anti-bodies accumulate in the blood, and therefore the blood serum gives us the clue of the best way of administering these anti-bodies in the case of a disease. Roughly speaking, all Bacteriological Institutes are engaged in considering the same problems; though there may be, perhaps, a division into two schools of investigation. In the one, Professor Metchnikoff, continuing at the Pasteur Institute in Paris to work at the fundamental problems and issues with regard to immunity from disease, is disposed to believe that the resistance to disease rests in the white blood corpuscles or phagocytes of the blood, and that therefore immunity acts as a direct vital process on the part of a body. This we may call the phagocytic theory. On the other hand, Professor Ehrlich, at Frankfort, and his school consider that immunity is preserved to the body not so much by its living agents (its white blood corpuscles) as by their products. This belief has sometimes been spoken of as Ehrlich's side chain theory.

THE SIDE CHAIN THEORY.

The toxins or poisons of a given organism when introduced into an animal act as a stimulus upon its cells. The result of this is that the cells throw into the blood an excess of certain substances which they nominally possess and by means of which, under ordinary circumstances, they are able to neutralize or fix poisons which may be in the system. Under the abnormal stimulus of a poison these substances are thrown off in excess and neutralise the poison in the blood before it can reach the tissues of the cells and damage them. According to Ehrlich the action and reaction of these substances into the poison are of a nature of a chemical process—similar to the chemical action by which an acid and a base unite to form a neutral salt—that is to say, that the anti-toxin combines with the toxin to form an inert body. Ehrlich's side chain theory imagines the body cell to be constituted of two or more parts; one may go further and imagine the invading organism or cell to be similarly composed of constituent parts—and when an invading cell enters the blood there is, as it were, an interchange, an intermingling, a combination of those parts of the body cell and of the invading cell which have chemical affinities. Thus the poison and the antidote may be at the same time produced; and the ultimate result depends upon the nature of the victor which emerges from this strife. The essence of the theory is embodied in Behring's words, "The same substance which, incorporated in the cells of the living body, is the pre-requisite for a poisoning becomes the means of cure when it exists in the circulating blood." So we may say that the living body possesses substances which may protect it by destruction of invaders or may injure it by destruction of its own cells according to the mates with which these substances are joined.

ANTI-TOXINS.

It will be seen that the first condition of a patent anti-toxin is the isolation of the toxin of the organ. That being found, we may in some cases produce the agents which we require for the chemical immunisation. The classic instances of the production of such agents are in the cases of diphtheria and tetanus. But after this bacteriological triumph, one might say that the science of production of anti-toxins had come almost to a standstill in recent years, inasmuch as the attempt to produce serums against other infective diseases

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have proved unsuccessful. The examples which most readily suggest themselves are those of the comparative failure in the case of the tubercle and the typhoid bacillus. Professor Wright's experiments in producing typhoid vaccine have had very interesting and valuable results; but his decoction of typhoid bacteria is not a serum. (In our present state of knowledge the most positive bacteriological process in connection with typhoid is the agglutinating effect which is produced when a typhoid culture from the laboratory is added to blood containing the typhoidal germ. In this experiment the bacteria coagulate and lose their motility.) The reason for the success in a few diseases and failure in most is that the toxins of diphtheria and tetanus are soluble bodies and pass out of the cells containing them—like the digestive ferments from the cells of the stomach. They can therefore be readily attained in fluid cultures. But it is different with tubercle and typhoid; and the endeavour to demonstrate presence of a soluble toxin in tubercle and typhoid has not met with success. The present point of view is that probably the poisons of these bacteria are of an intra-cellular nature and do not pass out of the cell under ordinary circumstances.

CELL-BREAKING.

The analogy in this instance is to be found in the yeast-cell; and it was for long supposed that the alcoholic fermentation of the yeast-cell was a purely vital act. But Buchner by triturating the yeast-cell and getting at its entire cellular constituents was able to produce an alcoholic fermentation by the constituents alone—without the aid of the living yeast-cell, thus proving that alcoholic fermentation was of the nature of a ferment anchored in the cell and not passing out of it under ordinary conditions. This has led to special attention being paid now not only to ferments, but likewise to the disease processes of the bacterial cells themselves, with a view to seeing whether the missing toxins were not, analagously to the ferment of the yeast cell, contained within the bodies of the organisms themselves. It has been known for some years that the only body with any marked poisonous properties as regards the tubercle bacillus was contained in the bacillus—hence the introduction of Koch's tuberculin, which is simply a decoction of tubercle bacilli, containing among other things the poisonous body. Similarly, the essential immunizing body in Haffkins's plague vaccine is a sterilized culture of the plague bacillus. The practical difficulty in obtaining these intra-cellular constituents is that of triturating such minute objects—which are sometimes only a fraction of a millimetre in diameter, and in this difficulty the liquid air of Professor Dewar has been of considerable use. Professor Alan MacFadyen, in experimenting with bacteria at these low temperatures, found that the effect of liquid air was to render the organic matter very brittle. A complete disintegration of the typhoid bacillus has been made in this way, and it has been found that the typhoid organism does contain an intra-cellular toxin, which may possibly be used for immunizing purposes and for the production of a serum.

RHEUMATISM AND THE TONSILS.

Among the new views which the new methods have enabled medicine to take for disease is the new view of rheumatism. A number of observers have detected in the joints of patients suffering from rheumatic arthritis organisms which undoubtedly appear to have a causal relation to arthritis; and which have been shown to produce joint lesions of the nature of arthritis. Thus, curiously enough, experimental research is confirming the old idea of the relation between the throat and rheumatic infection, inasmuch as there is now good reason to believe that the organisms which produce rheumatic affections of the joints gain access to the blood and thence to the joints by the tonsils.

Typhoid bacilli from a young laboratory culture showing flagella. A drop of serum taken from the blood of a person after inoculation causes these microbes to run together and become immobile.

REVIEWS OF BOOKS.

"Artificial Production of Spores in Monas," by Arthur White Greeley, one of the Decennial Publications of the University of Chicago (University of Chicago Press). This is a short monograph on a rather technical subject. "Surprisingly little is known," says the author, "about the physical and chemical conditions which determine the transformation of Protozon into cysts and spores." But a description is here given of a series of experiments, the general results of which show that in Monas a reduction of temperature brings about certain structural changes within the cell that result in the formation of many small spores, each of which has the power of reproducing the organism, so that it is possible, by varying the temperature, to control the methods of reproduction in Monas. At a temperature of 20° C., Monas multiplies sexually and by simple fission. At a temperature of 1° to 4° C. reproduction by asexual spores takes place.

"Problems in Astrophysics," by Agnes M. Clarke (A. and C. Black), 20s. This interesting work by the author of the well-known *"Popular History of Astronomy"*

A Spiral Nebula.

is one which will be carefully studied by all astronomers. While the history deals with the past, the present volume may be said to look to the future. Miss Clarke, in her preface, puts the matter in neat metaphor—"The object of the present work is not so much to instruct as to suggest. It represents a sort of recon-

A Nebula with Stars seen through it.

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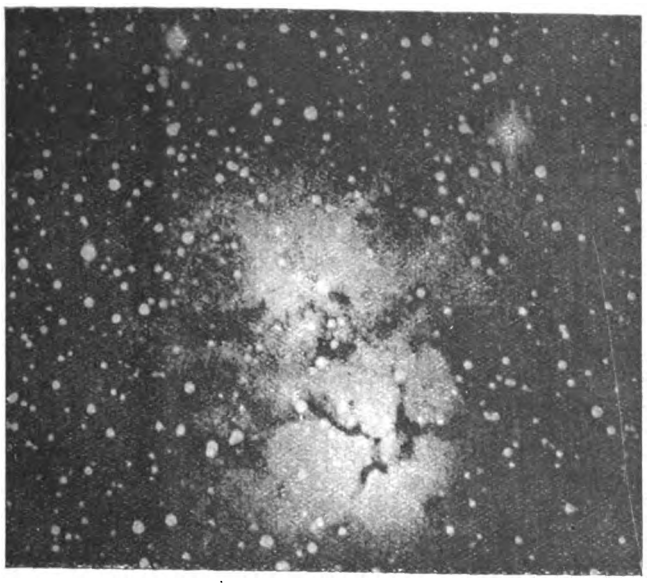
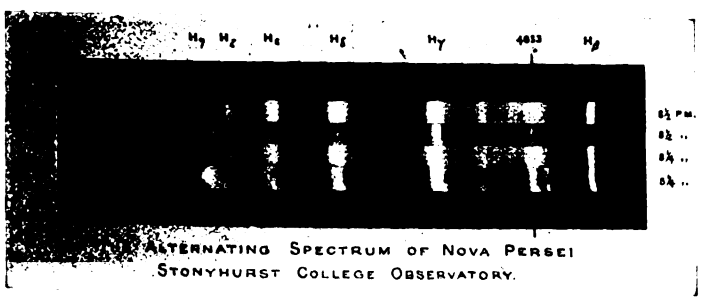
naissance, and embodies the information collected by scouts and skirmishers regarding practicable lines of advance and accessible points of attack, with a view to annexing, for the realm of knowledge, some further strips and corners from the territory of ignorance." The book is divided into two parts, the first dealing with problems in solar physics, the second with those in sideral physics. The chapter on "The Chemistry of the Sun" is of particular interest. The knowledge of this subject is, of course, based exclusively upon the analysis of solar light. The reversal of the Fraunhofer lines from bright to dark simply implies that the prismatic background of the photosphere is in a more intense glow than that of the ignited vapours through which the light is sifted. Fraunhofer's spectrum extended over nearly an octave. Photography discloses a higher half-octave in the ultra-violet end, but the infra-red offers a vaster scope for exploration. Prof. Langley has surveyed, by a "bolographic" method, a stretch of



A Nebula in the penultimate stage.

dark radiations eight times longer than the bright strip. The ultra-violet region is limited by the interposition of the air preventing the entry of quicker vibration. The infra-red has no such fixed limit. As a specimen of one of the many enigmas requiring solution which the author gives is that of the mysterious Nova Persei. Two photographs are reproduced, taken at Harvard College within a week. In the first there is no sign of a large star in the centre, while in the second a mass blazons forth larger than any other star in the field. It was on Feb. 22, 1901 that this strange object was first observed. On the evening of the next day it was brighter than Capilla, and "took rank as the premier star of the northern hemisphere." After that it rapidly dwindled. But the most remarkable characteristic was its spectral variability. At first the spectrum appeared as a continuous strip scarcely encroached upon by lines. On the following night the K of calcium stood out markedly. During the 24 hours following the maximum brightness, the spectrum



A Spectrum of Nova Persei.

was completely transformed. Hydrogen now blazed in it, and other peculiar and unexplainable characteristics were observable. For some time afterwards Nova Persei assumed the character of a variable fluctuating extensively in a period of three days, and the spectrum was found to vary in correspondence with the light. The photograph (here reproduced) taken by Father Sidgreaves shows four epochs, the first and third being typical of the higher grades of light, the second and fourth of the minimum state. The two types succeeded each other with approximate regularity for about six weeks, but no clue to their physical interpretation has been found. We could go on quoting other tales of the sort surpassing our comprehension. The book is so readable and absorbing that it acts as a pressing invitation to the reader to join the ranks of those explorers of Nature's abysses, who have so wide a field before them. It abounds with beautiful illustrations, from good photographs, of which we reproduce some small specimens.

"*Lenkbare Ballons*," by Hermann Hoernes, Captain in the Railway and Telegraph Regt. (Leipzig: W. Engelmann.) 15s. This is a very complete treatise (in German) on that subject which has lately made such progress—the construction of airships, or more properly, motor propelled balloons. Detailed accounts are given of each machine that has been built and tried in the past, together with a mass of suggestions and calculations as to what might be done in the future. But though the author has set forth on a difficult task with evident determination to carry it out fully and exhaustively, yet the information he supplies is not as complete as one might expect. For instance, he has concocted a great table to give summary dimensions, &c., of all the airships hitherto tried. These include no less than 17 different vessels. The length, diameter, section, surface, volume, lift, gas, dimensions of car, details of motor and of propeller, and many other details are included, but though a good many figures are duly filled in, there are also a vast quantity of blanks, many of which one would have thought could and ought to have been filled in. These are of especial frequency against the various machines of Santos-Dumont. Each machine is also fully described in the text, and numerous illustrations are given. There are a number of other tables, giving statistics of wind force (in Vienna). Some elaborate calculations are gone into in the several succeeding chapters as regards volumes, weights, and propulsive power. This is a work which should be invaluable to anyone thinking about constructing an airship, and he will, doubtless, find much useful instruction among the technicalities which are rather deep for the ordinary reader.

"*Absorption of Liquids by Animal Tissues*," by Ralph W. Webster. (The Decennial Publications of the University of Chicago Press). This is a highly technical contribution to the physical analysis of this question. Only recently has there been discovered one of the most fundamental theories concerning the exchange of liquids separated by membranes more or less semi-permeable. Substances in solution obey the ordinary laws of gases. They will therefore exert a pressure upon the walls of a containing vessel equal to the pressure which the dissolved substance would exert were it present in the gaseous form. A series of experiments are described on blood-corpuscles, on muscular tissue, and on other substances. Effects of non-electrolytes and electrolytes and of temperature are gone into, and a number of conclusions arrived at.

"*Scientific Protection*": A Guide to the Proper Application of Lightning Conductors, by Alfred Hands (J. W. Gray and Sons), is a small work on a subject but little understood by the general public, yet one of which it is most necessary that owners of houses and keepers of buildings should know something. The author points out that though lightning conductors have been proved by the experience of a century-and-a-half to be effective, yet they have often been found to fail. But, he adds, the failures can always be accounted for. Those who master the contents of this little book will know how to rectify the faults so often made in the fitting of lightning conductors, and will only have themselves to blame should they suffer loss by lightning.

Recent Patents.

17,076. Photography SCHUTTAUF, R., Carl Zeiss Strasse, Jena, Saxe-Weimar, Germany. Aug. 26.

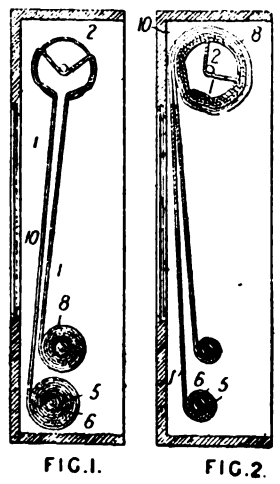


FIG.1. FIG.2.

Shutters.—Relates to a roller blind shutter with an adjustable aperture. The blind 1, Fig. 1, is passed through slits in the setting-roller 2, and its free ends are connected to the two winding-up rollers 5 and 6. In each of the two halves of the blind 1 are apertures 10 and 8, and the breadth of the exposure aperture is adjusted by winding either end of the blind on to its roller 5 or 6. Each roller 5, 6 is fitted with a spring to wind up the blind, and the friction of the folds of the blind on the roller 2 keeps the width of the exposure aperture constant during the movement of the blind. Fig. 2 shows the blind wound on the roller 2 before an exposure. Modifications of the method of connecting the blind to the roller 2 are described; only one of the rollers 5, 6 may be furnished with a spring, the other being geared to it. For time exposures, a bar may be pushed forward to catch a stop on the setting mechanism.

17,090. Reproducing Pictures at a Distance. BOULT, A. J., 111, Hatton Garden, London. —(*International Electrograph Co., Charleston West Virginia, U.S.A.*). Aug. 26.

FIG.5.

FIG.6.

FIG.8.

FIG.7.

Relates to a process of photo-mechanical printing and telegraphy. A picture, Fig. 5, is copied by a screen process to produce an enlarged copy, Fig. 6, either on an etched metal plate filled with insulating-material or on a metal plate having the insoluble gelatine left without etching. The copy, Fig. 6, is reduced at a distant station by ordinary facsimile telegraphy; the result is a reproduction in line as shown in Fig. 7. This is reduced by photography to prepare a process block corresponding to Fig. 8. It is stated that a coarse screen should be used in the first copying process.

17,194 Electric Lamps. BRITISH THOMSON-HOUSTON CO., 83, Cannon Street, London.—(*Read, R. H.; Schenectady, New York, U.S.A.*) Aug. 27. *Drawings to Specification.*

Arc lamps.—Electrodes are made with conductive metallic carbides, preferably those not much attacked by moisture, such as aluminium, chromium, zirconium, molybdenum, titanium, and wolfram carbides. These may be finely powdered, mixed with sugar or flour and water or tar, moulded, baked, and afterwards made denser by heating in hydrocarbon vapour, or saturating with sugar and heating. Carbides of calcium, barium, strontium, lithium, lanthanum, yttrium, thorium, and manganese, and others affected by moisture, are moulded with tar, baked, and paraffined, or used as cores in carbons, which are waterproofed by applying paraffin or metal coatings. Cut carbide cores may also be used. In striking the arc, the ends of the electrodes should be cleaned by slight lateral movement. If an enclosing-globe is used, the lamp should contain a wiper to clean it periodically; otherwise the globe may be kept clear by passing air through it. The arcs obtained are stated to be larger and steadier than with carbon electrodes; a good arc can be maintained with one ampère, using 50 watts in the arc. Calcium carbide gives a golden coloured light.

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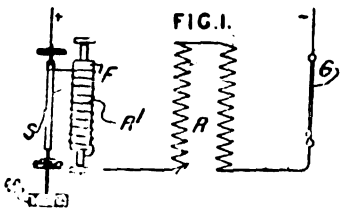
17,282. Electric Lamps. DRAKE, B. M., RAM, G. S., and NERNST ELECTRIC LIGHT (LIMITED), all of 82, Victoria Street, London, S.W. Aug. 29.

Incandescent lamps.—An incandescence body G of the Nernst type is placed in series with a steadying-resistance R, R^1, variable by hand or automatically to keep the current constant as the incandescence body becomes old, when the lamp is supplied at constant pressure. The part R of the resistance may be fixed, and consist of nickel. The variable part R^1 is adjusted until the fixed resistance R begins to show red in the dark. Several forms of the variable resistance R^1 are described. It may consist of nickel, platinum, or other wire wound on a porcelain insulator, a spring contact being movable along it by a screw with a milled head. Or the wire R^1 may be wound partly on a rotatable porcelain cylinder F, and partly on a parallel metal rod S, which may be turned by a milled head M in opposition to a spring acting on the cylinder F. Either of these arrangements may be turned automatically by electromagnetic means, instead of the milled head. In other forms, spring contacts are movable rectilineally along the resistance by a hot wire or a core and solenoid in opposition to a spring; or a hot wire helix may have its coils closed together more or less by a hot wire or a core and solenoid, to vary its temperature and resistance; or a hot wire sagged by a spring may be more or less short-circuited by contact with stationary curved metal strips.

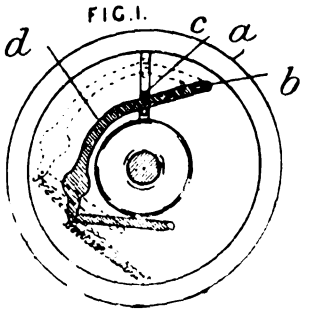
FIG.1.



18,990. Gas and like Engines. NICHOLSON, D., Bottom Farm, Covington, Huntingdonshire. Sept. 24.

Igniting.—The angular position of the armature of a magneto-electric machine is automatically adjusted relatively to the magnet, as the speed varies, by a centrifugal governor comprising a weighted lever *d* pivoted at *b* to the flywheel *a* and guided by a block *c* working in a radial slot; it is attached by a link *d* to the magnet or armature, whichever rotates. A similar device controls the contact-breaker.

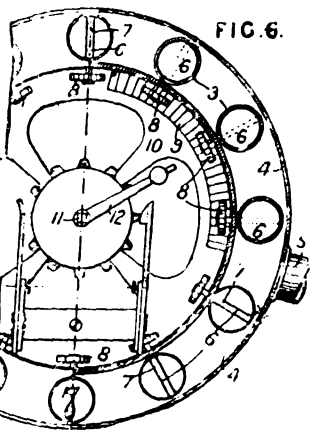
FIG.1.



19,315. Signals, marine &c.; sounds, locating. MEULEMEESTER, E. DE, 68, Rue de Neuchatel, Brussels, Belgium. Sept. 27. [Date applied for under SEC 103 of PATENTS &c. ACT, 1883, Feb. 28.]

Relates to apparatus for use on board ship, for receiving and determining the direction of the siren or similar signals, which are generally sounded on lighthouses and ships to indicate their presence when the state of the atmosphere does not permit of their being seen at a distance. The receiving-apparatus comprises a series of trumpets 1, Fig. 1, which are arranged around a mast &c. 2, so that one or more of them will receive a sound emanating from any distant point. In cases where the sails &c. might intercept the sounds from any particular direction, the series of trumpets may be arranged in sections in different parts of the ship. The trumpets are downwardly inclined, to prevent the entrance of snow, &c., and their lower parts are connected to extensions 18, which serve to collect the sound. The trumpets are connected by independent tubes 3, to a single ring-shaped tube 4, Figs. 3 and 6, to which one or more ear tubes 5, for use by the observer, are connected. Each tube 3 is provided with an obdurator 6, Fig. 6, which may consist of discs of rubber, felt, &c., mounted on axes 7, having pinions 8 adapted to gear with the rack 9 on the revoluble disc 10, which is carried by the axis 11 of the indicating-pointer 12. The gearing shown is adapted to close three of the tubes simultaneously, the pointer being directed towards the middle tube of the three which are closed, but two, or only one, of the tubes may be closed at a time. When the observer hears a signal, he turns the pointer until the sound is intercepted, the pointer then indicating on the dial the direction from which the signal is received. By noting the first observation, and making a second observation after an interval of time, the observer can determine whether the ship &c. from which the signal is emitted is stationary or not, and, in the latter case, the direction in which it is moving. The apparatus may be combined with an ordinary dial telegraph, adapted to repeat the indications to the officer on the bridge, the observer calling the attention of the officer by a bell &c. to the observed indications. Compasses may also be combined with the dials of the receiver and repeater, for convenience in determining the direction of the sounds.

FIG.6.



FIG

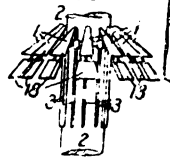
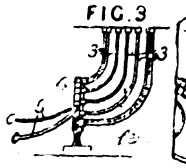


FIG.3



19514. Electromagnetic apparatus. THOMPSON, E., 15, Loudon Street, Calcutta, India. Oct. 1.

Motors, electromagnetic; electromagnets. — Relates to electromagnetic apparatus for producing vibratory or oscillating motion, especially applicable to call bells. An armature G, polarized by a magnet L, rests upon the two poles E and F of an electromagnet D^1, which have their ends inclined laterally in opposite directions, so that, when the armature rests squarely on the end of one pole, it will only rest upon the edge of the other. The armature is retained in position, while allowing the necessary motion, by means of screws or pins H passing loosely through holes therein and provided or not with springs. Alternatively, the armature is formed with inclined surfaces, the ends of the poles being flat. In the case of a call bell, the clapper is attached to the oscillating armature by a wire J.

FIG.1.

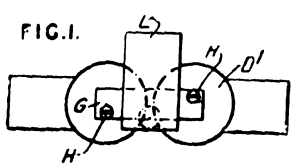


FIG.2

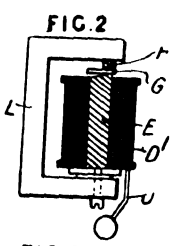
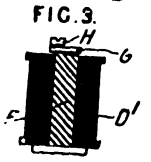
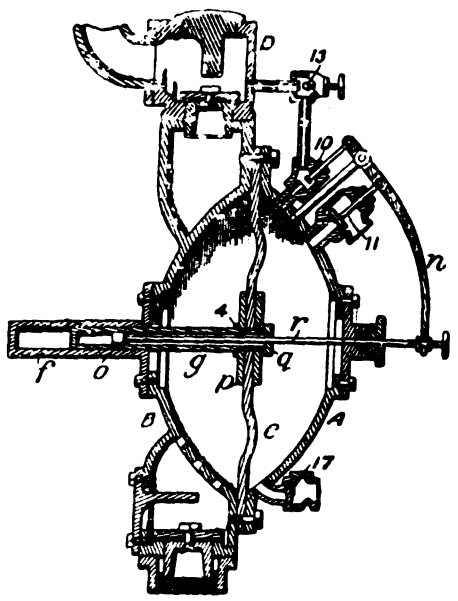


FIG.3.



19,300. Pumps. RAYNER, E. B., and KERNS, A. G., both of Piqua, Ohio, U.S.A. Sept. 28.

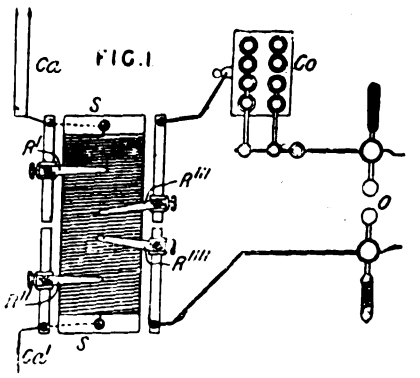
Direct steam-pressure apparatus; flexible-diaphragm pumps. — Between the two dish shaped parts A, B of the casing is clamped a flexible diaphragm *c*. Steam and condensing-water are alternately admitted at one side of the diaphragm by the valves 11, 10, while water is pumped on the other side of the diaphragm. A tube *g*, secured to the diaphragm by nuts *q*, 4 and plates *p*, slides in a guide *f*, and its opposite ends alternately engage a head *o* on a rod *r* connected to a lever *n* by which the valves 10, 11 are operated. The condensing-water is supplied from the delivery chamber D through a valve 13. A valve 17, opening outwards, allows the escape of water from the motor side of the pump.



19,461. Hertzian Signalling. DUCRETET, E., 75, Rue Claude Bernard, Paris. Sept. 30.

Relates to an adjustable single-coil transformer for use with Hertzian radiation apparatus for telegraphy and otherwise. A single coil of wire or wires S is provided with two pairs of adjustable brushes R^I, R^{II}, R^{III}, R^{IIII} for the primary and secondary circuits. Fig. 1 shows the connection to an aerial conductor Ca, earth Ca^1, condenser Co, and spark gap O. A coherer, such as described in Specification No. 2797, A.D. 1900, may be used at the receiving-station.

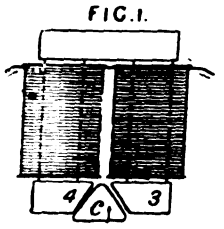
FIG.1



19,462. Electromagnets. DUCRETET, E., 75, Rue Claude Bernard, Paris. Sept. 30.

An electromagnet is provided with pole-pieces 3 and 4, adapted to receive a wedge-shaped armature *c*, having a straight or curved section. The pole-pieces may be variously arranged, and the armature may move in the direction shown by the arrow, or at right angles thereto. Such magnets may be employed, for example, in periodical interruptors for Ruhmkorff coils, electric bells, calls, electric motors, telegraphic and telephonic instruments, relays, and the like.

FIG.1.



19,504. Photography. MARTIN, K., Rathenow, Prussia, Germany. Sept. 30

Lenses.—Relates to a photographic lens which is spherically, chromatically, and astigmatically corrected. In the simplest form, it consists of a negative meniscus D, Fig. 1, of higher refraction, and a positive lens D^3 of lower refraction, which are arranged so as to leave a space D^2 between them which has the form of a negative lens. A double objective, Fig. 2, may be made up of two of the simple sets.

FIG.1

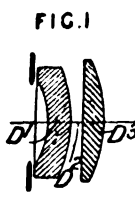
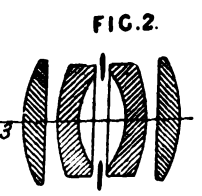
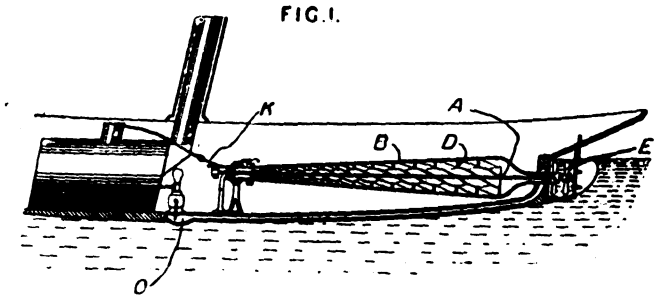


FIG.2.



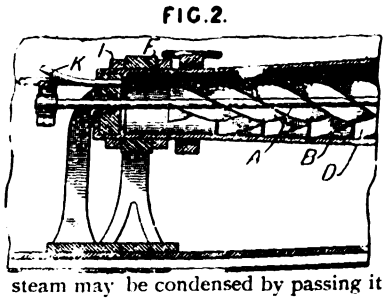
19,568. Turbine Motors. Astor, J. J., 23, West 26th Street, New York, U.S.A. Oct 1.

FIG.1.



A turbine motor for marine propulsion is shown in Fig. 1 applied to a ship. The shaft A and tapered casing B have oppositely-arranged spiral blades D and screw propellers E. The forward ends of the shaft and casing are supported in bearings I, F, Fig. 2, and they rotate in opposite directions when steam &c. is admitted through a pipe K. The bearing I of the shaft fits in and forms a support for the end of the casing. Brakes may be applied to both the shaft and casing. The exhaust steam may be condensed by passing it through the hollow keel O of the ship.

FIG.2.



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Renovation of Air by Sodium Peroxide.

Two short articles in the ILLUSTRATED SCIENTIFIC NEWS on the above subject have elicited many enquiries and much interest, and this is not to be wondered at, since a method of automatically renewing the oxygen of the air which has been consumed in the lungs of human beings, and at the same time absorbing the carbonic acid given out, must be one of great importance. We have therefore instituted investigations, and, with the able assistance of so great an authority as Sir William Crookes and several other experts we are enabled to give a number of facts which may be of use to those interested in the subject.

Peroxide (or bioxide, which is practically the same thing) of sodium was formerly considered of no practical value. It was only recently discovered, as related in a former number, that it possessed the valuable properties now claimed for it. The action is due to the fact that the peroxide readily combines with carbon dioxide, forming carbonate of soda, and evolving pure oxygen. The amount of the latter generated is of a volume equal to that of the carbon dioxide absorbed. The action is facilitated by the addition of water, and Dr. Desgrez and M. Balthazard have devised an apparatus for feeding the sodium peroxide in small charges into a receptacle of water, to which the air is drawn by a small ventilating fan.

The amount of the chemical practically required is an important consideration, and is one not easy to decide without practical experience. Now, the average quantity of carbon dioxide in expired air is 4·3 per cent., and the amount of air passing through the lungs in one hour is about 20 cubic feet. That is to say, nearly one cubic foot of carbon dioxide is given out every hour. It has been found that 1 lb. of the peroxide is capable of absorbing about 65 litres (2⅓ c. ft.) of carbon dioxide and giving off that quantity of oxygen. Hence we may conclude that ten pounds of the substance will last for 24 hours. This, then, accounts for the carbon dioxide. The oxygen consumed by the person will be slightly in excess of this, but the respiration varies so greatly with circumstances, such as the age of the subject, if resting, or working, &c., that these figures can but give an approximation of the amount required.

Then a great deal will depend upon the exact purpose for which it is intended, and whether to form the sole supply of breathing air, or only to augment the supply, as in an ordinary room. The purposes to which this system seems applicable may be summarized as follows:—

1.—For the better ventilation of dwelling rooms, work rooms, hospitals, &c., where there is already a certain supply of fresh air, but in which it is desirable to eliminate the vitiated air.

2.—It may, perhaps, prove of great use in the treatment of invalids, such as consumptive patients, where fresh air without cold is a great desideratum.

3.—In mines and wells liable to become choked with unbreathable gases, when a quantity of the chemical may be thrown down to clear the air.

4.—In smoke-laden air, such as firemen may have to encounter, when a helmet or respirator may be charged with the peroxide, and enable the wearer to penetrate the fumes.

5.—In diving-dress, allowing the diver to move about without the impediments of air-pipes.

6.—In submarine boats, where the air supply is a difficulty.

For divers and for other purposes where the whole air supply must be provided, and where the person is working hard and consuming the maximum amount of air, it may be necessary to provide double the quantity of peroxide usually required, or say one pound an hour. On the other hand, if the person be resting and weak, he will not require nearly so much, and if in an ordinary room a large proportion of the vitiated air will be carried off. One is apt to forget how well ventilated a room is under normal conditions. Take an ordinary door, for instance, 7 ft. high by 3 ft. wide. If the crack around it averages only one-eighth of an inch wide, the aperture will be equal to a pipe 6 inches diameter, and if the air be drawn through this opening at the rate of wind described as "just perceptible," that is to say 3 to 4 ft. a second, 60 cubic feet of fresh air will be provided per minute, or more than enough for twelve people! But if the temperature of the air on both sides of the door be the same, no current of air will pass. It is therefore impossible to say what is required for the proper ventilation of an ordinary room. That is entirely dependent on the circulation of the air. In practice it is desirable to spread the peroxide out so as to expose as great a surface as possible to come in contact with the carbonic acid. It should be in the form of powder spread on a plate or tray. This is of a slightly yellowish or lemon colour. After being acted on by the impure air, it turns to a pale orange-red, some grains being darker than others, and finally, after long exposure, it becomes pure white. So that it is fortunately quite easy to see when the chemical has changed its composition and become exhausted.

As regards the cost of this useful substance, though an ordinary retail chemist may charge considerably more, if bought in large quantities it can be procured for 1s. 7d. a pound. It may, then, seem rather expensive as a means of ventilation, but for medical treatment, for warlike purposes, or for when life is to be saved, expense need scarcely be considered.

And it is not only human beings that may benefit by the properties of this air-giving powder, for it may prove of use in stables and kennels, and especially in the cages in zoological collections. Monkeys and other delicate animals suffer greatly from pulmonary complaints, doubtless caused by the stuffy atmosphere in which they are usually kept for warmth.

Notable Articles in Recent Periodicals.

Electro-Magnetic Rotations. (Illustrated.) *Scientific American*, Dec. 27.
T. A. Edison (with portrait.) *Scientific American*, Dec. 27.
Spectral Photography. (Illustrated). *Scientific American*. Dec. 27.
French Light-Weight Automobiles. (Illustrated.) *Scientific American*, Dec. 27.
Mutual Aid. (Review.) *Nature*. Jan. 1.
Sound Waves and Electro-Magnetics. Oliver Heaviside. *Nature*, Jan. 1.
Babylonian and Assyrian Legends. *Nature*, Jan. 1.
A Pot of Basil—A Mosquito-Ridding Plant. *Nature*, Jan. 1.
The Microscope (diag.). *English Mechanic*, Jan. 2.
The Water-Tube Boiler Question. (Illustrated.) *Machinery Market*, Jan. 1.
Water-Tube Boilers in the United States Navy. *Steamship*, January.
Liquid Fuel. Kermode's System. (Illustrated.) *Machinery Market*, Jan. 1.
"Sentinel" Air Compressor. (Illustrated.) *Steamship*, January.
Use of Electricity on Board Ships. *Invention*, Dec. 27.
The Mechanical Inventors of Lancashire. *Invention*, Dec. 27.
Oiled Roads. (Illustrated.) *Agricultural Economist*, Jan. 1.
Applied Optics (continued). (Diagram.) *British Optical Journal*, January.
Magnalium (continued). *British Optical Journal*, January.
Yellowstone Geysers. (Illustrated.) *Scientific American Supplement*, Jan. 3.
Self-Registering Water-Meters. (Illustrated) *Scientific American Supplement*, Jan. 3.
American Indian Medical Practice. *Scientific American Supplement*, Jan. 3.
Water-Tube Boilers. (Illustrated.) *Scientific American Supplement*, Jan. 3.
Mankind in the Making. *Fortnightly Review*, January.
Decline and Fall of the South African Elephant. By Mr. H. A. Bryden *Fortnightly*, January.
Professor Pupin's Long Distance Telephony. *Electrical Review*, Jan. 9 and 23.
Mr. James Swinburne on "Entropy." *Electrical Review*, Jan. 16.
Commercial Education and University Degrees. *Economic Review*, January.
Seismological Observations. Prof. Milne. *Geographical Journal*, January.
Fessenden Wireless Telegraph System. (Illustrated.) *Scientific American*, Jan. 3.
Snow and Ice Clearing. (Illustrated.) *Scientific American*, Jan. 3.
Ancient Ruins of Palenka. (Illustrated.) *Scientific American*, Jan. 3.
Similarity of Short Period Barometric Pressure. *Nature*, Jan. 8.
Recent American Botany. *Nature*, Jan. 8.
The Granites of Egypt. (Illustrated.) *Stone Trades Journal*, January.
Lebaudy Dirigible Airship. (Illustrated.) *Scientific American*, Jan. 10.
Folding Rangefinder (Prof. Forbes). *Scientific American*, Jan. 10.
First Section of the Pacific Cable. (Illustrated.) *Scientific American*, Jan. 10.
Senses of Lower Animals. (Illustrated.) *Scientific American*, Jan. 10.
Progress of Astronomy in 1902. *English Mechanic*, Jan. 16.
Eyes of Insects. (Illustrated.) *English Mechanic*, Jan. 16.
The Hewit Mercury Lamp. *Nature*, Jan 15.
Vibration of Gun Barrels. (Illustrated.) *Nature*, Jan. 15.
West Indian Eruptions. (Illustrated.) *Nature*, Jan. 15.
Water-tube Boilers. (Illustrated.) *Scientific American*, Jan. 10.
Irrigation (Illustrated.) *Scientific American*, Jan. 10.
Airbrakes for Railway Trains. (Illustrated.) *Scientific American*, Jan. 10.
Metric System. *Journal Society of Arts*, Jan. 23.
Prof. Lorenz's Treatment. *Nature*, Jan. 22.
Formation of Pearls. (Illustrated.) *Nature*, Jan. 22.

Lectures to be delivered in February.

MOSAIC CONSTRUCTION.—Feb. 4, 8 p.m. Society of Arts, John St., Adelphi)—W. L. H. Hamilton.

PORT OF LONDON.—Feb. 11, 8 p.m. Society of Arts (John St., Adelphi)—Dr. G. W. Ginsburg.

THREE COLOUR PRINTING.—Feb. 18, 8 p.m. Society of Arts (John St., Adelphi)—Harvey Dalziel.

INDIAN CENSUS.—Feb. 26, 4.30 p.m. Society of Arts (John St. Adelphi)—J. A. Baines, C.S.I.

PAPER MANUFACTURE.—Feb. 2, 9, 16, and 23, 8 p.m. Society of Arts (John St., Adelphi)—Julius Hübner.

HEALTH DANGERS IN FOOD.—Feb. 13, 8 p.m. Royal Institution (Albemarle St.)—Prof. Sheridan Delepine.

MEASUREMENT OF ENERGY.—Principal E. Griffiths, Feb. 20, 8 p.m. Royal Institution (Albemarle St.).

PERFUMES: NATURAL AND ARTIFICIAL.—A. Liebmann.—Feb. 27, 8 p.m. Royal Institution (Albemarle St.).

Feb. 6.—Royal Institution (Albemarle Street)—Sir H. Maxwell on "Romney."

Feb. 13.—Royal Institution (Albemarle Street)—Prof. Delépine: "Health Dangers in Food."

Feb. 20.—Royal Institution (Albemarle Street)—Principal Griffiths: "The Measurement of Energy."

Feb. 26.—Royal Institution (Albemarle Street)—Mr. G. Murray: "Ocean Flora."

Feb. 27—Royal Institution (Albemarle Street)—Dr. Liebmann: "Perfumes"

Feb. 3, 10, 17.—Royal Institution (Albemarle Street)—Professor McFadyen: "Digestion."

Feb. 5, 12, 19.—Royal Institution (Albemarle Street)—Sir Clement Markham: "Arctic and Antarctic Exploration."

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The Science of Illusion.

SOLUTION OF MYSTERY NO. 4.—THE TRANSMITTED CARD.

THE apparatus for accomplishing this trick is very simple. A long piece of elastic cord, at least three or four feet long, has one end fixed behind the scenes, and to the other end is fastened a dark thread of such a length as to reach to the far table when the elastic is fully stretched. If there is not sufficient room in the "wings" for the elastic to stretch, unseen, in line with the tables, it can be placed up and down or any other way with the thread leading round a sheave or pulley, on a level with the tops of the tables. The elastic is now stretched, and so held by a loop of string round a nail, &c. The performer takes the end of thread with him on the stage, which he fixes to the card. This may be done either by a small piece of cobbler's wax, or butter, by simply taking a twist of the thread round the card, but the latter method is difficult to do and difficult to explain, but may soon be acquired in practice. Having placed the card on the further table, he puts the hats down, so that there is room under the brim for the card to pass out. An umbrella or stick is placed on the near side of the hat on the near table, on top of the thread. When all is ready the performer fires a pistol (to prevent the sound of the spring being heard), and at the same moment an assistant releases the elastic. The result is that the card is rapidly drawn from under the far hat across to the near hat, when it is stopped by the umbrella, the thread flying off behind the scenes.

Prize Competition.

ONE of the principal objects of this journal being to encourage and foster the introduction and propagation of new ideas, the proprietors have decided to offer a series of money prizes to those who, in their opinion, send in the best and most practical solution of certain problems which will be set each month.

The designs must be sent in within a fortnight of the publication of the problem, *accompanied by the coupon* cut from this paper. Marks will then be allotted by the judges, and the competitor gaining the greatest amount of marks each month will be awarded the monthly prize of ONE GUINEA. But in order to encourage clever inventors, and not merely reward those who may happen to hit upon a happy idea, a GRAND PRIZE OF **ONE HUNDRED POUNDS** will be awarded at the end of the year (*i.e.* after 12 problems have been set) to that inventor who shall have gained the greatest aggregate of marks during that period, provided he shall have gained at least *30 per cent. of the full marks* in at least six of the competitions (whether he has gained a monthly prize or not).

In the event of an equality of votes or other exceptional circumstances, the proprietor will decide on the fairest method of distribution.

The following rules must be strictly adhered to, and solutions sent in not in compliance with them will be disqualified.

1. The solutions sent in must be concise, yet fully descriptive of the idea intended. To comply with this they must not exceed 300 words, and not more than two simple diagrams should accompany it.
2. Solutions will be published as considered desirable by the editor.
3. Competitors may obtain patent rights for their ideas, but they must run all risk of the publication in this paper interfering with the obtaining of such rights.
4. The number of marks awarded to each solution will be published every month. Competitors may send in their designs under a fancy name for publication, but their true names and addresses must be inserted on the coupon, which, in the event of their winning a prize, will be published.
5. The same person may send in two or more solutions so long as a separate coupon accompanies each.
6. Novelty of design is not a *sina qua non* (since this would be extremely difficult to prove), but only the person sending a description with the coupon is entitled to reward.
7. It would add to the value if a statement be added to say if the design has been practically tried; but to corroborate this the inventor may be called upon to give a demonstration before receiving a prize.

Results of last month's Competition.

"REGULATING BALLOONS."

(Full marks 100.)

A number of solutions, differing only in details, have been sent in, which makes the allotment of marks specially difficult. The principle mostly in favour is that of compressing the gas of the balloon, or the atmospheric air, so as to render it heavier. With the compact little petrol motors now made, and if proper precautions are taken to prevent any possibility of lighting the gas, the idea seems practicable. The great difficulty is, however, the weight of the receiver. It must be remembered that the cylinders used in our army for compressed hydrogen weigh 70 lbs., and only contain 100 to 120 c. ft. of gas compressed to 100 atmospheres.

SECOND WEST No 2 (**87**). Two screws or concentric shafts beneath car rotated by petrol motor. *(Awkward position for descent.)*

A SPENCER (**80**). Balloon closed up so that no gas can escape. Material capable of withstanding pressure of 3 lbs to square inch. A minor, internal balloon is connected with hand pump. On inflating latter the whole of the gas is compressed. *(Though the calculation is not given, such maximum compression would imply a pressure of ¼ atmosphere. If gas in balloon was 30,000 c. ft. it could be compressed to 24,000, which is equivalent with hydrogen to a loss of lift of 420 lbs, while the weight of the air compressed in the inner balloon (6,000 c. ft) must also be added. So that an ample margin is allowed for. We cannot doubt the practicability of constructing such a balloon, as this competitor is one of the greatest authorities on balloon construction. At the same time we have some doubts as to the possibility of compressing the gas sufficiently fast with a hand pump.)*

R. FENTON (**76**). Two screws, mounted on ends of horizontal pole projecting each side of car, geared to windlass in car worked by hand or motor.

CYRIL BURRAGE (**72**). Air is compressed by a pump into an internal small balloon, strongly made. *(In this the main balloon is not closed up, so that the whole difference in weight is that due to the compression of the air in the inner balloon.)*

SECOND WEST No 3 (**72**). Pump operated by motor compresses gas from balloon into three steel cylinders each containing 120 c. ft. (presumably 120 c. ft. of hydrogen compressed into cylinders of 1 c. ft. capacity), and weighing 70 lbs. Thus 340 c. ft. of gas can be pumped from the balloon and added to the weight of the cylinders. This only makes a difference in the lift of about 20 lbs. *(This is certainly not much gain, when the apparatus weighs fully 250 lbs.)*

L. R. CONNOR (**70**). Air is compressed into steel cylinder by petrol engine. If cylinder 200 c. ft., and air compressed to 10 atmospheres, an additional weight of 138 lbs is obtained. *(A cylinder of 200 c. ft. would be a cumbrous addition. A smaller cylinder and the air compressed to a higher degree would probably be better, but even this is very heavy.)*

BACILLIGRAPH (**69**). Skeleton cylinder of bamboo or wire enclosing strong india-rubber bag placed inside balloon. Bellows, worked manually or by motor, transfers gas from balloon to receptacle, and compresses it.

WINDBAG (**68**). Also suggests compressing the gas from the balloon into a receiver which might be under the floor of the car, pump worked by hand. *(No dimensions or weights are given.)*

KHARKI (**67**). Gas pumped from balloon by hand into reservoir. *(No details of weights given.)*

F. KOWACHI (**67**). *(Very similar.)*

HUMBER (**65**). Fan worked by electric motor draws gas from balloon and compresses into steel cylinder. *(Electric motor heavy.)*

KASS (**60**). Combines two principles, a force pump compressing gas in chamber, and two fans revolve on each side of car.

E. M. F. (**58**). Valvular wings worked by hand. *(This tried with some success a few years ago by Dr. Danilewski.)*

HARDSTAFF (**50**). One on top of balloon, other beneath car, light shaft passing through balloon. *(Long shaft objectionable.)*

SECOND WEST No 1. (**45**). Air drawn from ballonet, heated by passing through stove, and returned as required.

FEZ (**43**). Small, strong, inner balloon compressed by means of cords surrounding it. *(Another principle described by three competitors is that of working vertical screw propellers.)*

A. C. T. (**35**). Small balloon attached by long cord wound on windlass, rope wound in causes ascent of main balloon. *(Very temporary effect unless very long rope.)*

CANTAB (**30**). Two inverted parachutes lowered alternately on long ropes, drawn in by winch to cause balloon to descend.

MEPHISTO (**30**). Combines several. Gas pumped into reservoir. Boiler for warming gas. Cover over balloon to mitigate effect of sun's heat. "Transmarine" apparatus pumps water up into vessel by its motion.

EROS (**28**). Hydrogen obtained by electrolysis from water, stored in cylinder, for use. *(Heavy apparatus and slow process.)*

X. Z. Balloon divided in two by vertical diaphram. One half painted black, the other white. To rise turn black half towards the sun, thus gas warmed. To sink turn white half to sun. Balloon rotated by a kind of oar *(Ingenious suggestion, but not very practical, as sun would often not be shining and effect would not be great.)*

DR. BIDDLE (**0**). *(Though the ideas sent are ingenious they refer to hot-air, and not gas balloons. They were also sent in too late.)*

The Monthly Prize of One Guinea has therefore been awarded, to

MR. PERCIVAL SPENCER,
45B, Aberdeen Park,
Highbury, N.

A question having arisen as to the marks allotted in cases where one competitor sends in two or more solutions, it has been decided that all marks gained by any competitor will count for the grand prize, though the monthly prize will be awarded for the best solution, and not for the aggregate of marks of one competitor.

KASS. Please note above new ruling.

A.C.T. has sent in a different nom de plume with every solution. This is confusing though not infringing any rule.

We regret that some readers have a difficulty in getting the journal punctually. We always issue a day or two before the 1st of the month.

The subject for next month will be—

AN IMPROVED RANGE FINDER,

an instrument for measuring distances up to a mile or more.

(Coupons to be delivered at this Office not later than February 15th.)

COUPON.

To the Proprietor, ILLUSTRATED SCIENTIFIC NEWS.

I herewith forward my idea for a solution of the problem on "An Improved Range Finder," according to the conditions published in your paper, and I agree to comply with those conditions.

Full Name .....

Address .....

.....

Fancy Name for publication .....

Date .....

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THE ILLUSTRATED

Scientific News.

A Monthly Journal devoted to Popular Science.

VOL. I. No. 6. [Entered at Stationers' Hall.] MARCH, 1903. SIXPENCE. By Post, 7½d.

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Coherers.

Some Experiments on Loose Contacts.

BY ROLLO APPLEYARD, A.M.INST.C.E.

I HAVE been asked by the Editor of ILLUSTRATED SCIENTIFIC NEWS to describe some of my experiments upon coherers. This request takes me back through a period of about thirteen years, for it was in 1890 that I first published an account of some curious developments of the microphone principle, and showed how a tuning-fork could be kept in continuous vibration by a very simple adaptation of it.

VIBRATING TUNING-FORKS.

In this experiment, a tuning-fork is mounted upon the same resonating box as a simple microphone, as shown in Fig. 1. A horse-shoe electro-magnet is so arranged that the prongs of the fork are free to vibrate between the projecting poles. The electro-magnet is connected in series with the microphone and with a battery. If now the prongs are given a sudden impulse, enough to set them going, the vibration is conveyed to the loose contact of the microphone, the current reacts upon the prongs, and the prongs react upon the microphone. There is thus a continuous rapid transformation of mechanical, electrical, and magnetic energy, by a vibratory process which keeps the fork in continuous motion, resulting in a musical sound. For the experiment to be successful the magnetising force requires to be fairly strong, and the microphone requires careful adjustment. It will be observed that this method of driving a tuning-fork leaves the prongs entirely unencumbered by contact pieces. Nevertheless I doubt whether it would be the best method of driving standard tuning-forks, for it is probable that the changing magnetic field in which the prongs move has some distorting effect upon their motion.

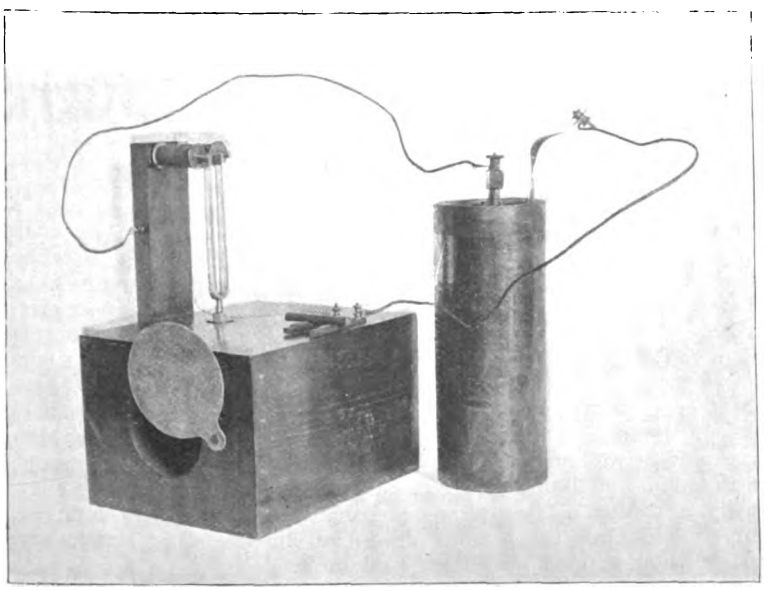

Fig. 1.

BUZZING IN THE TELEPHONE.

In the same year I explained that some of the "buzzing" sounds heard in telephones were probably to be attributed to a similar reciprocating action. For if a telephone, Fig. 2, is mounted on the box, in place of the tuning-fork, and the current is great enough, the telephone gives utterance to a continuous note. This principle has been very greatly developed since that time. The motion produced in the loose piece of a simple three part microphone when a current exists in the circuit is no doubt akin to the motion of the vibrating block of a Trevelyan rocker, such as is described in the text-books of Physics. These rockers were very carefully studied by Tyndall in 1859, and by Seebeck in 1840. Nearly fifty years ago it was noticed by an electro-gilder named Fearn, of Birmingham, that a loose cylindrical metal rod placed across the bars of his trough oscillated in an erratic manner upon the two conductors. This phenomenon can easily be observed by making a sort of microphone of three arc-lamp carbons, two of them parallel, and a third placed loosely across at right-angles to them. When a current of two or three ampères is sent through this large microphone, the loose rod rolls erratically or oscillates upon the fixed ones. Another way of showing this motion is to place a loose carbon ball in an annular channel formed between two flat carbon rings, or a ring and a disc, as shown in Fig. 2 and to connect this to a battery. The ball certainly moves, but its motions, like those of the rod in the previous experiment, are very capricious. I found, however, that these erratic movements could be made more periodic by a very simple device. This experiment is illustrated in Fig. 2. The parallel carbon rods are mounted in the manner there shown, and the transverse rod is weighted with a pendulum which should be rigidly attached to the transverse rod. If the pendulum is very light it will sometimes roll over and over as the transverse rod rotates. But if the weight is nicely adjusted and the current is of right value, say about two ampères, it will swing steadily for a long time in continuous periodic motion. Here then are all the makings of an electric clock without weights and without a spring. In all these experiments the motions are no doubt due to the fact that an oscillating rod moves quickest in the middle portions of its path, slowing up towards the end of each oscillation, and for an instant

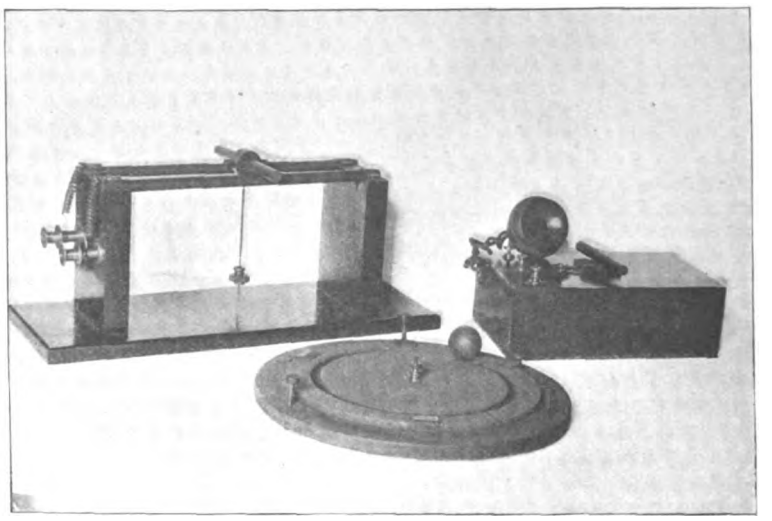

Fig. 2.

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resting at the end of each half swing of the pendulum. The current through the loose contact varies in like manner, so also does the production of heat at the points of contact; consequently, periodic expansions and contractions of the carbon occur along the little path of oscillation. These expansions are therefore automatically timed to rotate the rod through a part of a revolution at the very moment that such a slight force if repeated is calculated to cause continuous pendulation. A very small child can work a very big swing with a very big man in it, provided that the successive impulses are exactly timed. Thus it is with the vibrating rods when thus tilted by thermal expansions. The terminal impulses are minute, but they are timely, and consequently effective. It is probable that the active particles of all microphones move in some such periodic way, at different periodicities, according to the tone to be transmitted.

SOLID COHERERS.

In 1894, before I was aware of the experiments of M. Branly and others on coherers, I was testing the electrical resistance of a

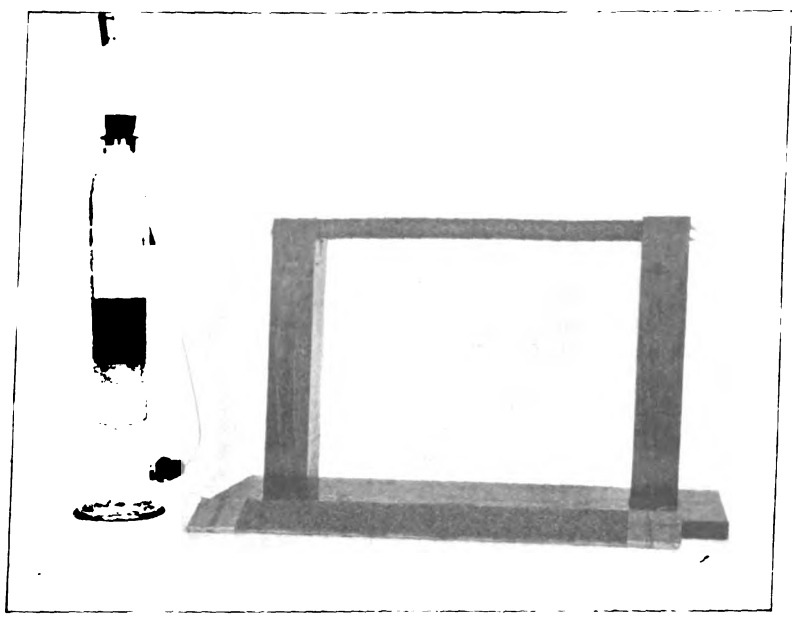

Fig. 3.

large number of dielectrics, and was struck with certain anomalies that occurred in the case of celluloid, which under certain circumstances, depending apparently upon the nature of the contact surface, exhibits "electrification" with a minus sign. That is to say its resistance appears to *diminish* with time as the current is applied. In seeking an explanation for this curious phenomenon I was led to make up a compound, a sort of pudding, consisting of gutta-percha and brass filings. It is really remarkable how great a proportion of brass filings can be combined in this way with gutta-percha without making it conduct. For instance, in a particular case a rod 20 inches long and ¾ inch diameter, Fig. 3, composed of two parts of gutta percha to three of brass filings, had still the enormous resistance from end to end of 283,000 megohms. But if by any means a spark was passed through such a rod the resistance as a rule became much less. These rods in fact behaved like coherers. This particular rod broke down at 6,500 alternating volts, and little electric arcs shot out normally to the surface like very small blowpipe blasts, some crimson and some violet.

VISIBILITY OF COHERENCE.

The mystery attaching to the action of coherers is deepened by the invisibility of the process. In 1897 I set to work to try and make a coherer, the action of which should be visible, and was thus led to the use of liquid coherers and mobile conductors. In the first experiment a glass tube about eighteen inches long and half an inch wide is sealed at one end and corked at the other. Platinum electrodes are inserted at each end. The tube is nearly filled with about equal volumes of paraffin oil and mercury. If this is vigorously shaken for a few minutes the mercury breaks into small spheroids; and by a little manipulation these can be disposed as a chain of particles lying more or less evenly between the electrodes. The resistance of this chain of mercury spheroids in oil and water is several megohms. If we now connect the electrodes to a battery of about 200 volts the spheroids are visibly impelled as though a mechanical tap had been administered to the glass. Almost simultaneously they coalesce into large globules, and the resistance is now represented by a few ohms. The same result can be brought about by supporting the tube near a Hertz oscillator; or still more simply by passing a spark into the tube by means of the electrodes. The tube should be kept in the horizontal position so as to avoid the spontaneous running together of the globules.

OIL AND WATER.

Another experiment was arranged as follows. A glass tube, Fig. 3, a glass flask, or a Wolff's bottle, is about two-thirds filled with a mixture of about equal parts of paraffin oil and water. The oil can be coloured with alkanet* root, which has the property of imparting a rose tint to the oil while not colouring the water at all. This I call the "rain" tube. It is first shaken vigorously so that an unstable emulsion is formed. But if a spark is passed into the mixture, a sudden separation takes place, and the oil now occupies its normal position upon the water. The water particles suspended in the emulsion cohere at the moment of electrification, to form large drops. The frictional resistance to falling is thereby diminished, simultaneously with the coherence, so that the water is precipitated in and through the oil, like a shower of rain following thunder.

MERCURY GLOBULES.

The best known of my experiments is perhaps the "mobile conductor." A little mercury is poured into a flat-bottomed photographic dish, Fig. 4, containing just a stratum of paraffin oil and water. The presence of the oil is necessary to prevent the drops of mercury running together too freely. A battery of, say, from 1 to 100 volts is required, according to dimensions, and a pair of wires to dip vertically into the dish. A reversing key, such as is used for cable transmission, may be included in the circuit. Suppose we begin with a large globule of mercury in each of any pair of corners of the dish, several inches apart, and let the globules be connected one to each pole of the battery by means of the dipping wires. A momentary tap of the key causes instantaneous deformation of the mercury in each corner, especially of that connected to the negative pole; and there is evident attraction between the globules. Sometimes the mercury gets into a lethargic condition, but it can always be roused by mechanical agitation of the surface. Now let the current be kept on for a few seconds; the negative globule sends forth a tentacle towards the positive globule, the length of the tentacle depending upon the current and the distance between the globules. Under favourable circumstances it may extend from corner to corner, and thus establish contact; or *fissure* may occur, the tentacle breaking into spheroids. These spheroids may actually cross over from one globule to the next. This is the order of things usually to be observed, but the action is sometimes erratic. Let us now bring back the scattered globules of mercury to their respective corners, and distribute, by hand, a few isolated spheroids in the interspace. In addition to the effects previously noticed at the terminal globules we now see that, when the current is applied, each intermediate spheroid extends a "finger" towards the positive globule. This is the process of mobile coherence; the short-fingers or long tentacles form links between consecutive spheroids, and finally there is established a complete conducting circuit. By successive applications of the current, any elongated bodies of mercury between the terminal globules can be made to creep along like caterpillars;

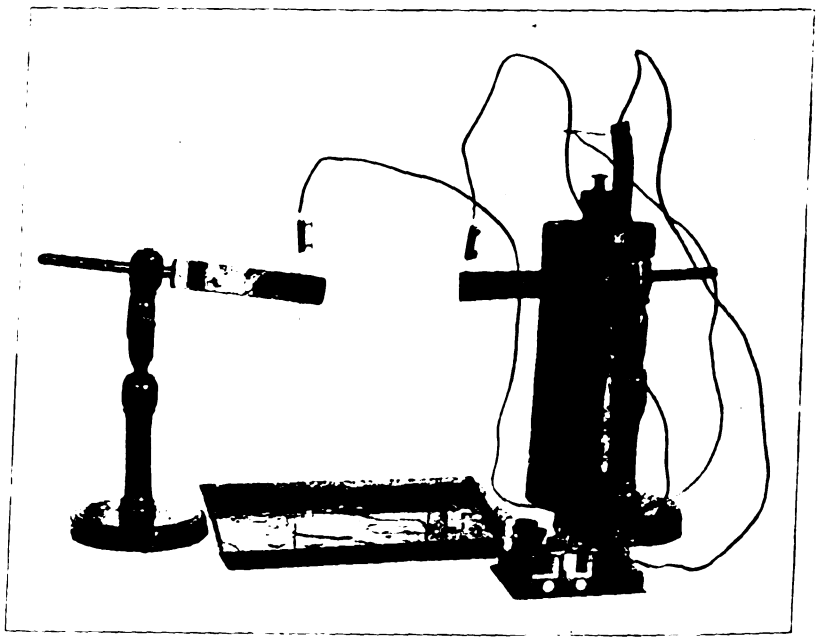

Fig. 4.

the successive forward motions of the tentacles or tails cause a corresponding retrogression of the globules as a whole. Any small spheroids scattered about the dish may be urged in a direction depending upon the direction of the successive current impulses. A finger will always appear on the side towards the positive electrode. Hence by choosing a convenient stray spheroid in the dish, and operating a battery reverser as a transmitting key, a telegraphic receiver is improvised from no other apparatus than a drop of mercury in an oily dish. In seeking an explanation of the phenomena of electrical coherence from these various experiments it is well to keep in mind that similarity of *results* obtained with solid and liquid coherers respectively does not prove similarity of *process*. The process of coherence is extremely complex, for probably all the actions described in this short article and many other actions play their part in it.

* *Anchusa tinctoria.*

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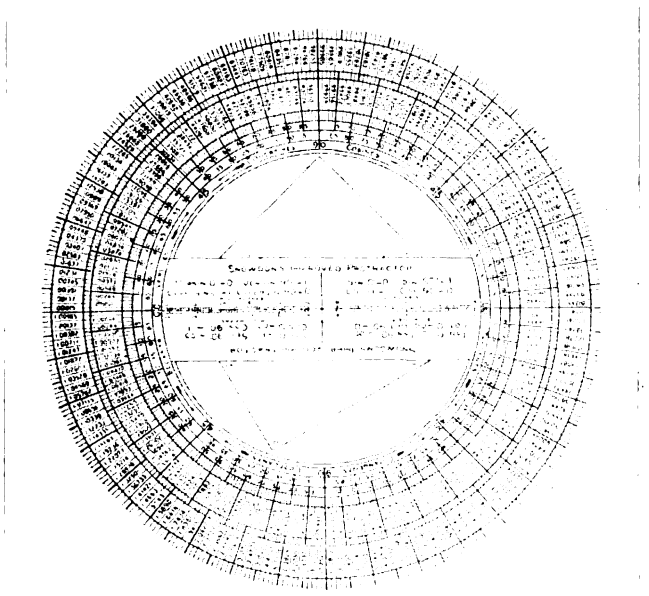
Snowdon's Protractor.

ALL those, and they are many, who have, in the course of their work, to deal with angular measurements may find a simple instrument, devised by Mr. F. Seaton Snowdon, to be of the greatest use. This consists of a disc of metal, celluloid, or cardboard, about 8 inches diameter, around the edge of which not only are degrees



shown, but against each is marked in clear figures all the trigonometrical values. Instead, therefore, of having to turn up the tables in a book, the sines, cosines, tangents, &c., can be found at a glance. Other useful details are given, such as a scale of inches and millimetres.

The Great Red Spot on Jupiter.

AN address by Professor G. W. Hough to the American Association for the Advancement of Science does a great deal to clear up the mystery that has surrounded the phenomenon known as the great red spot on the planet Jupiter—a reference to which appeared in the February number of the ILLUSTRATED SCIENTIFIC NEWS. According to Professor Hough, the great red spot is neither a new apparition, nor specially mysterious in its appearances or disappearances. The disappearances, as they are called, he attributes largely to defects of instruments, and to insufficient accuracy on the part of observers. If observers had always fixed the size and position of the red spot on Jupiter, when it appeared, by micrometrical measurement, as he himself has done since 1879, he thinks we should have heard less about its mysterious disappearances. It was observed first in 1665, and appeared and receded eight times between 1665 and 1708. The longest time that it was visible was three years, the longest time invisible, five years. It was said to have "re-appeared" in 1878—a time at which for various reasons many telescopes were directed at Jupiter, and it has been often under close observation since. Professor Hough describes it as a vast elliptical spot, of about 3,000 miles in its largest diameter, or one-tenth the diameter of Jupiter. If its depth is equal to its width its volume is about three times that of the earth. It has appeared to have a drifting motion, both longitudinally and latitudinally, quite independent of its rotation with the planet. It is said by some observers to have drifted round the planet three and a quarter times since 1879, and to have drifted latitudinally about four thousand miles —which, comparatively, is not a great deal. Professor Hough is inclined to believe that the longitudinal drift is exaggerated, and that the true time of rotation of the planet itself is underestimated. From close and continual observation of the planet, its equatorial belts, its great red spot, and the smaller egg-shaped white spots, Professor Hough has reached the following conclusions: that the visible boundary of the planet Jupiter, which is still at a very high temperature, though not hot enough to emit light, has a density only about half that of water; that this medium is of the nature of a liquid, and in it are located the great red spot and the black and white spots, all of which are at a lower level and float in the liquid; that the equatorial belts of Jupiter are at a higher level, and consist of some form of vapour of considerable density; and that in the middle latitudes of Jupiter the higher atmosphere carries a layer of dark matter of the nature of an envelope, in which are openings showing as spots. Professor Hough holds that the proximity of the red spot causes alteration of temperature; that it has volume and mass, and can neither be of the same material as the belts nor can it be regarded as a cloud.

The Star of Bethlehem.

THE present is a year of small comets. For the first great event of the century we shall have to wait seven, or it may be eight, years. It has sometimes been supposed that the Star of Bethlehem, the shining herald of the Christian Era, was a conjunction of two planets. Mr. Davies Forbes in the *Optical Journal* has hazarded the supposition that the celestial apparition was the comet known as Halley's Comet. The comet has an interval of approximately 75 years, 10 months, and 6 days; and became visible when it last appeared in October, 1835. It will, therefore, probably be seen again in 1911. Halley, who was appointed Astronomer-Royal in 1719, and who had seen the comet in 1682, predicted its return in 1759. Several of its 76-year reappearances have been observed. The defeat of Mithridates by Pompey was signalised in B.C. 152 by one of them. Josephus tells us of another of them at the destruction of Jerusalem about 75 A.D. Mr. Forbes therefore contends that one of the returns of the comet between these two dates must have been about the date of the birth of Christ, some months before the Wise Men saw "His Star" in the East. The comet would then be on its course towards the sun; and on its return six months later it would be in the zenith above Bethlehem about the end of December. Anybody who begins to compute subsequent dates will perceive, however, that the comet is some fifteen years out, and should have returned not in 1835 but in 1820. Mr. Forbes surmounts this difficulty by remarking that it was not until the sixth century that Dionysius made out our present chronology, and made at that time an error of fifteen years. The error has become stereotyped, and the present year should not be 1903 but only 1888.

The Theory of Electricity.

SIR OLIVER LODGE ON ELECTRONS AND ATOMS.

A MOST interesting lecture on "Electricity and Matter" was delivered last month at Bedford College by Sir Oliver Lodge. Referring to the three fundamental properties of matter—gravitation, cohesion, and inertia—the lecturer said that as to the first we still remained very much in the dark; as to the second, the same might have been said ten years ago, but now there were signs that its secret was being given up; while inertia we were beginning to understand. In self-inductance electricity had a property resembling inertia. Twenty-five years ago he would have called it a mechanical analogue; to-day he would say that electricity had real inertia—indeed, that there was no inertia except electrical. In other words, we were now arriving at an electrical theory of matter, and explaining it in terms of electrical action, of which, in fact, we knew far more than of matter. A body charged with electricity, if at rest, presented the phenomena of electrostatics; if in motion, those of electricity and magnetism; if in acceleration or change of motion, those of light and radiation generally. Inertia existed all the time. All electric phenomena seemed to depend on electrons. The electrons might not merely be vibrating, but might be revolving round the atom; in that case this orbital motion of a charged body would act as an electric current and be affected by a magnet. On this assumption Lorentz predicted the influence of magnetism on light which was sought by Faraday as the magnetisation of light and found by Zeeman recently. The electrons had to travel at an enormous speed round the atom, and in consequence some of them were occasionally thrown off tangentially—a process which was facilitated by ultra-violet light.

On the hypothesis that matter was composed of electrons, their size was known—they were about the one-hundredth thousandth part of the diameter of the atom. If the electrons were magnified up to something like the size of a full stop, an atom would be a church 200ft. long, 80ft. broad, and 40ft. high. In an atom of hydrogen there were nearly 1000 electrons; that number would occupy the church in the same way that soldiers occupied a country, they would keep everything else out. The atom was thus a scene of great activity. In the mercury atom there were 100,000 electrons; still, these did not fill all the space, and if the distances between them were calculated, they seemed to be about as far apart in proportion to their size as the planets in the solar system. By their force the atoms came to be impenetrable; chemical affinity also appeared to be electrical in nature, cohesion was turning out to be of an electrical nature too, while, as already said, there was good reason to believe that electric inertia was the only inertia in existence.

In acknowledging a vote of thanks, Sir Oliver Lodge said that had it not been for his engagement to lecture that afternoon at Bedford College he would have been at Cambridge attending, as a representative of the Royal Society, the funeral of Sir George Stokes, to whose great influence on the progress of science he referred in appreciative terms.

WITH regard to the two portraits of Mr. Marconi in our last issue, we omitted to mention that they were taken at the Biograph Studio, Regent Street.

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The Nernst and the Cooper-Hewitt Electric Lamps.

These are two inventions, the one by a German scientist, the leader of modern thought in the domain of Chemical Physics, and the other the invention of an American, the son of one of the best known of American statesmen. The two lamps are operated on totally different lines, but both are intended to accomplish one object, among others, viz., the cheapening of the production of light by electric currents.

The Nernst Lamp.

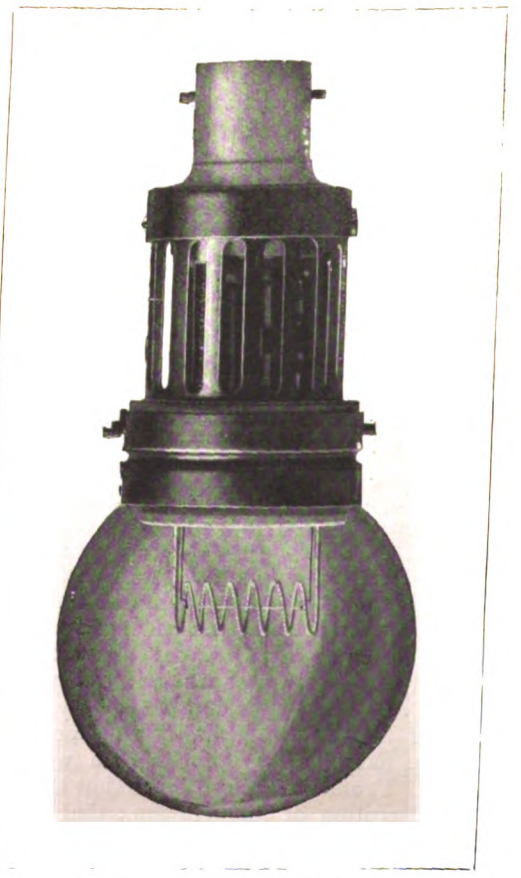
In the Nernst lamp, the inventor has attempted to do for the ordinary incandescent electric lamp what the Welsbach mantle did for gas. It will be remembered that in the Welsbach mantle the

Nernst Lamp—200 Volts.

lace-work is made from some of the earths, such as Yttrium, Thorium and others, and the great object accomplished by these earths is the ability to withstand very high temperatures without destruction. In the Nernst lamp, the part which corresponds to the filament in the ordinary incandescent lamp is made also from the rare earths, but in place of its being in a long thread, it is made in the form of a short pencil, and is called the "glower." When the proper current is passing through it, the "glower" gives out an intense white light, literally glows. But the pencil of the rare earths has one drawback, it is a good conductor of electricity when hot, but almost an insulator when cold; hence an addition has to be made to the usual arrangement of the incandescent lamp, in the form of a heater. The heater consists of a platinum wire coiled round the "glower," and a current is allowed to pass through the heater when he lamp is to be lighted, until the "glower" has attained its ro per temperature, when the current is automatically switched off. The switching off again entails another addition to the lamp in the form of an Electromagnet, with a contact attached, the contact being broken when the heat of the "glower" is at its proper figure. And this is not all, the "glower" is very sensitive. It will go out if the current passing through it is allowed to be below a certain figure for a certain time, and will then require to be relighted by means of the heater. To obviate this another addition has been made to the lamp in the form of the regulator, which consists of a fine iron wire enclosed within a glass tube, and included in the circuit of the "glower." The fine iron wire is proportioned so as to be near its critical point, with reference to its Electrical resistance. If the current passing through it is above a certain figure, the resistance of the iron wire is comparatively high, while if the current sinks below that figure, the resistance is comparatively low. The result is that the iron wire takes up any surplus pressure which is present in the circuit, and gives up the pressure when the current falls, by decreasing its resistance. The running pressure supplied to the lamp is higher than would be necessary if it were not for the sensitiveness of the "glower," and the surplus pressure is taken up by the iron wire. If, however, the pressure falls below the critical point, instead of the "glower" losing its heat and ceasing to give out light, the iron wire surrenders the pressure it has absorbed, or a portion of it, and the "glower" goes on burning, just as an ordinary incandescent lamp does. The whole of the apparatus are enclosed in what is virtually the lamp holder. The efficiency of the lamp is 1·5 watts per candle, as against 3·5 to 4 watts per candle with the ordinary incandescent lamp; and notwithstanding the apparent complication, it burns very satisfactorily. Some 600 Nernst lamps were employed to illuminate the Canadian Arch in Whitehall at the Coronation. The lamp does not burn in a vacuum. In some towns the effect of the introduction of the Nernst lamp has already been felt in decreased lighting load. In houses of entertainment, for instance, groups of incandescent lamps have been replaced by single Nernst lamps with economy and success. The Nernst lamp requires to be switched on a little time before the light is actually required, from a half minute upwards, according to the situation. It is sold in this country by the Electric Co., of Charing Cross Road, London, W.C.

The Cooper-Hewitt Lamp.

This lamp is on a totally different principle, and is only just bidding for the favour of the general public. It is being exploited in this country by the Westinghouse Company, Norfolk Street, London, W.C. It is an extension of the vacuum tube, which has been a favourite lecture experiment for so many years. A tube which may be from 3 inches long and ½-inch in diameter to 12 feet long and 3 inches in diameter, has a bulb at one end, as shown in the drawings, in which a certain quantity of mercury rests. At each end of the tube is a platinum wire sealed into the glass in the usual way, dipping into the mercury at one end, and itself forming the Electrode at the other end. The tube is exhausted as fully as possible. To light the lamp a reactance coil is switched into the circuit of the lamp, and switched out again, the induced pressure resulting being sufficient to start the vaporisation of the mercury. A small quantity is converted into vapour, and through this the proper current which is to be used in



Nernst Lamp for Street Lighting.

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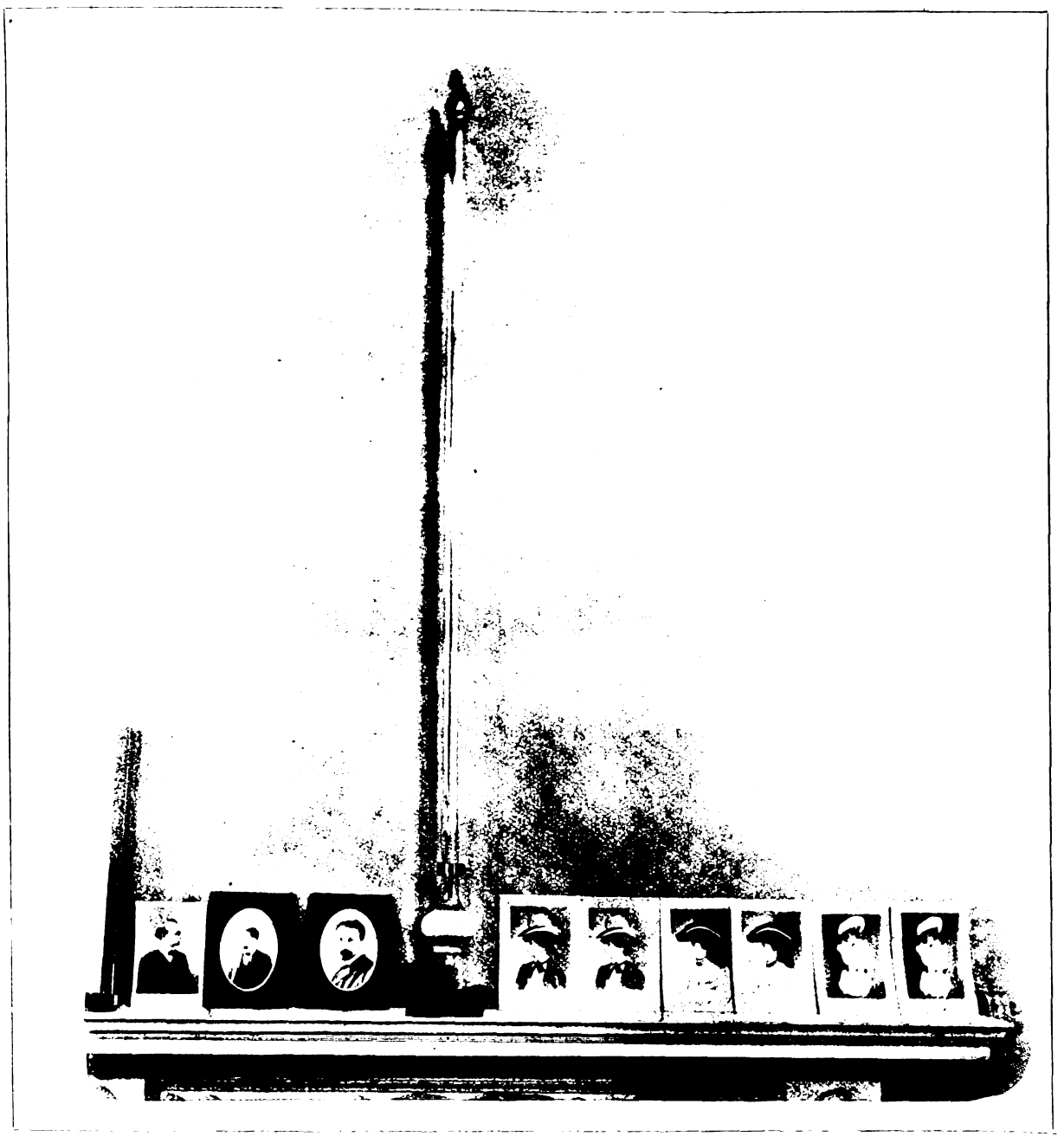
the lamp passes. In a few seconds sufficient mercury vapour is formed to allow of sufficient current passing to cause the vapour to glow with an intense light, just as the old experimental vacuum tubes did, but very much brighter. The light given is, in fact, quite suitable for illumination of any kind, except that it contains only a portion of the spectrum, the violet, blue, green and yellow rays, the red rays being very deficient. The effect is somewhat ghastly for some purposes. Red and pink, and similar colours, look more or less black, and one's hands and face look somewhat death-like; but the general effect apart from this is not unpleasing for many purposes. The economy of the lamp is stated to be much higher than anything yet produced—viz., ·5 of one watt per candle, as against 1·5 for the Nernst, and from 3·5 to 4 for the ordinary incandescent lamp. The lamp on show at the Westinghouse Company's offices is 40 in. long, the tube having a bore of 1 in. diameter, and it takes a current of 3 amperes with a pressure of 80 volts. The lamp is apparently indestructible. After a certain number of hours burning, dirt accumulates on the Electrodes, and on the mercury, and the lamp is opened, cleaned with soap and water, re-exhausted, and is stated to be as good as new.



Cooper-Hewitt Mercury Vapour Lamp of 40-Candle Power.

THE COOPER-HEWITT STATIC CONVERTOR.

Mr. Hewitt has worked out a very pretty apparatus as an extension of the lamp described above for converting alternate currents into continuous. It consists of a bulb as shown in the drawings

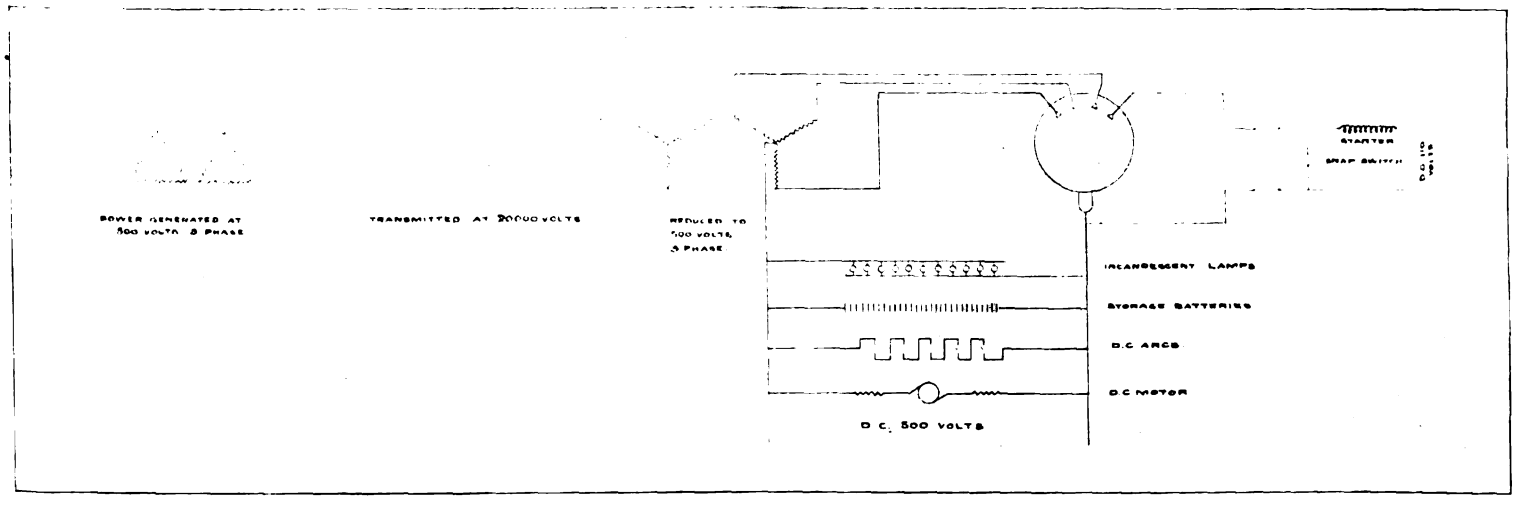


Diagram of Connections for converting 3-phase 2,000 volt alternating current to 500 volt continous current by Cooper-Hewitt Mercury Vapour Static Convertor.

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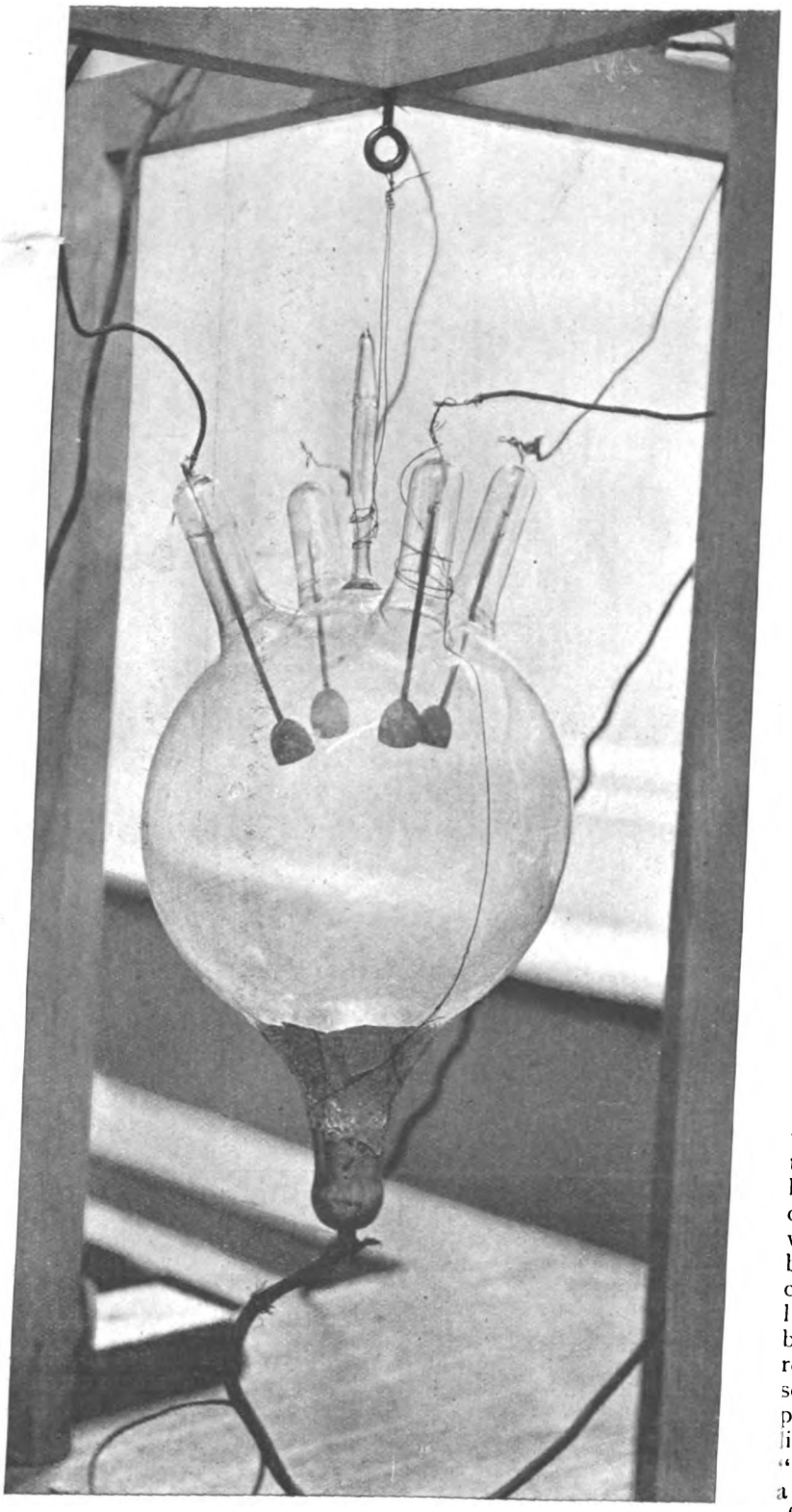
with one negative terminal, and as many positive terminals as there are phases in the alternate current. Each phase is led to its own terminal, and the common negative is connected to the common connection of the alternate current winding on the transformer or generator. The negative Electrode is mercury as in the lamp, and the positives all iron, with platinum wires sealed in the glass for connecting to the service wires. There is also an additional positive terminal for connection to a continuous current supply, which has also a reactance coil in circuit; and the convertor is started in the same way as the lamp. A high tension continuous current spark is allowed to pass from the continuous current positive to the mercury,



Cooper-Hewitt Mercury Vapour Static Convertor, arranged for 3-phase current.

starting the vaporisation of the mercury. The continuous current is then allowed to pass through the convertor for a certain time to warm it up, and the alternate currents are then allowed to pass. The effect is to transform half of each of the cycles of the alternate currents into continuous currents. It is claimed that the currents are not merely rectified, but that actual continuous currents are produced which can be used for charging accumulators. With single phase currents the conversion is simply from alternate to continuous, but with two or three phase currents the pressures from the separate phases are added together in the return wire, in which the apparatus to be worked is connected. One important feature of the apparatus is it only makes a constant charge of 14 volts no matter what the pressure is nor what the current, so that for high pressures it should be very efficient. It will be understood that the apparatus does not transform from high to low tension, or vice versa; it only converts from alternate to continuous current, the pressure after conversion being the same as before less the 14 volts.

What to Eat and What——

IN concluding the extremely able series of lectures which he has been delivering at the Royal Institution on "Digestion," Professor McFadyen summed up a few partly recognised truths about foods and food stuffs in a manner both terse and forcible. The first of his remarks were directed to the meat extracts, beef essences, beef teas, and soups which form so large a part of modern dietary, and which are sometimes advertised as providing in themselves sufficient sustenance for "human nature's daily food." This is so far from being the case, that, generally speaking, a beef extract may be described as not being a food at all, but merely a stimulant. It consists of some ninety-six per cent. of water. The rest may be partly fat; but its meaty taste is little more than taste, and is in fact largely due to the "creatin" and "creatinin," which impart flavour to meat. When soup is made from meat, the flavour of the meat, its "creatin," is extracted; but the solid nutriment remains behind —in the tasteless meat. Oysters, also, Professor McFadyen, considered were a much overrated article of diet; and had a very small nutritive value. He might have added that their digestibility, especially when taken in bulk, as at the Colchester Oyster Feast, is very greatly overestimated. As regarded fish, Professor McFadyen continued, there was a popular belief that this form of food contained a great deal of phosphorus, and was consequently good for brain workers. There was no foundation whatever for this belief and no experimental evidence to show that fish contained more phosphorus than any other form of animal food. By way of compensation for this disappointment, fish was to be regarded as a good form of animal food, easily digested and assimilated because of its short muscular fibres. Fish and lean beef were about equally digestible. Lean beef, in its turn, was more easily digested than fatty mutton. The cold fat of mutton was especially inimical to quick digestion. Cod and whiting, which were lean fish, were more digestible than salmon, mackerel, and eel, which were fatty; and while the whiting was the most digestible of fishes, and almost, of all animal foods, the herring occupied perhaps the first place for nutriment and digestibility combined. Among vegetable foods, the pea, bean, and the lentil ranked first. The lentil was one of the most ancient forms of food, and the red Egyptian lentil probably was the constituent of Esau's mess of red pottage. Professor McFadyen concluded by remarking that an exclusively vegetarian diet was obviously unsuited to the human organism, because the digestive tract of a human being was only about one third that of an animal, which was herbivorous.

Can a Molecule Become Visible.

THERE are limits to the magnifying powers of the microscope partly because there are limits to the sensitiveness of the human eye, and partly because of the properties of light waves. The more a microscope magnifies an object the smaller is the portion that can be seen and the less is the light available for the purpose; and when the objects are as small as the $\frac{1}{5000}$th of an inch, we are approaching the dimensions of the wave lengths of light themselves. No way has yet been found of preventing the waves from interfering with one another at the edges; consequently very minute objects appear with coloured fringes at the edges; and are indistinct. With the best microscopes, however, an object of about the $\frac{1}{100000}$th of an inch can be made visible though not distinct. It appears as a point or line. A new method of increasing visibility has been investigated by Messrs. Siedentopf and R. Zsigmondy which may be described roughly as combining the principles of the telescope and the miroscope. A telescope makes an hitherto invisible star visible by providing a larger artificial eye with which to collect all the rays of light emanating from it. Messrs. Siedentopf and Zsigmondy "collect" the light emanating from the ultra-microscopic object, on a principle roughly analagous to this. In the result they have effected a magnification equal to 50,000 diameters. The utmost limit to which this method can be pushed is about 150,000 diameters, let us say, at most, something between the $\frac{1}{100000}$th and the $\frac{1}{1000000}$th part of an inch. Even this, however, is ten times the diameter of a molecule. So that our prospects of ever seeing a molecule are as far off as ever.

Coal v. Gas.

SOME rather unexpected results have been brought to light by recent tests in America of the steam-rising capabilities of coal and natural gas respectively. The price of the coal used was put at 9s. a ton, while that of the gas was 4d. per 1,000 cubic feet. But the cost of evaporating 1,000 lbs. of water was found to be, by gas 8½d., and by coal 6d. Further tests with other varieties of coal proved still more economical, the cost coming out at 3d.

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A Railway in the Air.

THE BARMEN-ELBERFELD SUSPENDED RAILWAY.

IN May next, the German Emperor will open the Barmen-Elberfeld-Vohwinkel Suspended Railway for public traffic.

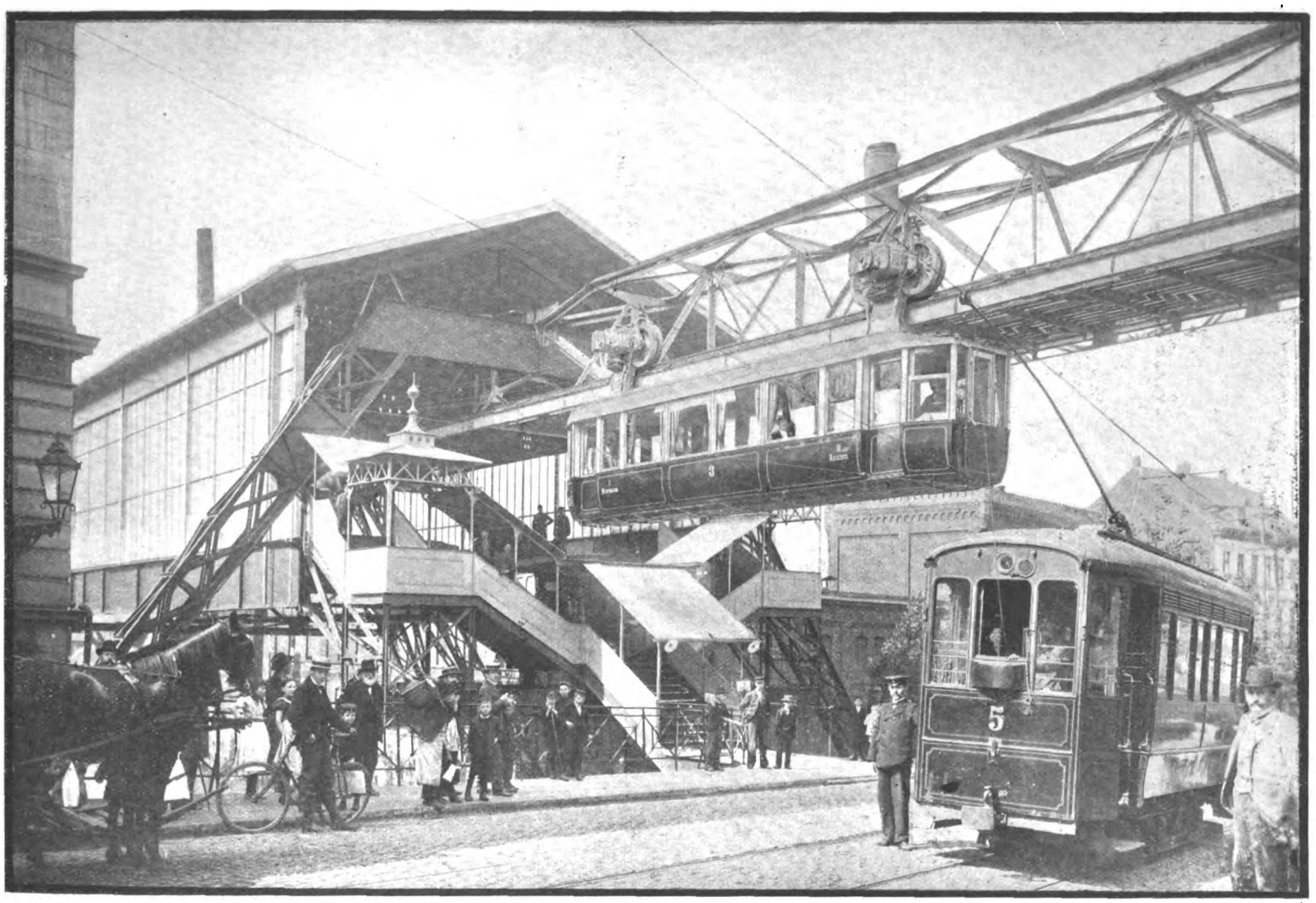
This is the only electrically-operated Suspended Railway in the world, and the working of the new line will be watched with great interest by engineers all over the world. In the opinion of some, this form of travelling will solve the problems both of Rapid Transit in Great Cities, and also of Express Passenger Travelling, and many new lines of this character are contemplated. In 1893, the municipalities of Barmen and Elberfeld came to the conclusion that they ought to provide greater facilities than existed at the time for intercommunication. Many schemes were proposed and considered, but finally the Mono Rail Suspended Railway was chosen. This system is the invention of Herr Eugen Langen, who died at Cologne in 1895.

One of the chief reasons which led to the choice of this railway was the fact that it could be constructed for the greater portion of its length over the River Wüffer, which runs through the valley in which lie the towns of Barmen and Elberfeld and the suburbs of Sonnborn and Vohwinkel. The supports for the track in the larger mono-rail may be of different design. In the suburbs of Sonnborn and Vohwinkel, quite another kind is used to that which is employed over the river and the outlying densely populated and less busy portions of the line.

Instead of A-shaped frames we have here what are known as "Portal Frames." These consist of two uprights and a curved section fitting on to each of these. The advantage of this arrangement is sufficiently obvious, and it will at once be seen that it obstructs the road much less than does the trestle structure.

The supports of the portal frames have been placed near the kerbs of the sidewalk where they do not occupy more space than the street lamp-posts. In many cases, indeed, they take the place of the lamp-posts, the lamps being attached to the supports. In Sonnborn and Vohwinkel the rail tracks of the carriages are, to a certain extent, hidden by the foliage and branches of the trees. No one can claim that the railway is an æsthetic addition to the towns, but, at any rate, it is less open to objection than the elevated railroads to be found in the States, from which are apt to drop coals, cinders, or water. Yet a third form of support consists of a central single post carrying the rail on each side. It is, perhaps, the most pleasing variety of the three. Where the suspended mono-rail passes over the River Wüffer the inclined struts supporting the track sometimes have their foundations in concrete, embedded in the solid ground. The cars, which are suspended beneath the track, run on a single rail, the rail on the other side being used for the return. The train always travels over the line in the same direction and is never reversed. The lower edge of the car is about 15 feet above the road pavement and so there is but a short stairway up to the platform. At the terminus at Vohwinkel are repair shops, and, when necessary, the cars are lowered and raised again by means of lifts.

The trains are brought to standstill by means of hand brakes and automatic Westinghouse compressed air brakes, or by reversing the current, or by cutting off the live current. Each train will, as a rule, be made up of two cars joined together, though more will be added as occasion demands. The car used is 37 feet long and 6 feet wide; it can accommodate 50 passengers, who enter and leave by the side doors, opening inward. The car swings free beneath the track and is suspended from the "bogies" 26 feet apart, each running on two wheels of 35 in. diameter driving a 36-horse power electric motor fixed between the two wheels projecting outward. The current is taken up from the conducting rail by a contact shoe. The weight of a carriage with its full complement of 50 passengers is estimated at 14 tons.



The Elberfeld Suspended Railway--A Station.

To travel in a car suspended in mid air from a single rail may seem to many a risky proceding, but great precautions have been taken to prevent the cars from falling, and it is extremely unlikely that such an accident will ever occur. The length of the Barmen-Elberfeld Suspended Mono Rail is 13·3 kilometres (8¼ miles), and 10 kilometres (6·2) miles are above the River Wüffer, whose width varies between 85 and 115 feet.

The line begins at the Barmen-Rittershausen station of the State Railway, follows the course of the Wüffer through the towns of Barmen and Elberfeld, and then leaving the river follows the main road through Sonnborn and Vohwinkel to its terminus in the last-mentioned town.

A number of side extensions (in the shape of ordinary electric surface trains) are contemplated, especially in the last-mentioned suburbs, to which it is expected the business men of Barmen and Elberfield will flock when better rail service has been provided. The curves of the main track have an average radius of about 300 feet; in a few cases it is less, falling to 100 feet. In the side

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tracks, however, curves of even 27 feet occur, but the motion is perfectly smooth, not the slightest inconvenience or shock being experienced.

On one of the trial lines, interesting experiments were made with buckets filled with water and placed in the carriages. In travelling at full speed round the sharpest curves not one drop of the water was spilled, the whole surface of the liquid yielding to the motion of the car and maintaining its level, thus giving a conclusive proof of the steady motion of the cars while running round curves. One or two doubtful points concerning the working of the line will probably occur to the reader. A railway in mid-air

The Suspended Railway over Suburban Street.

cannot be managed on precisely the same lines as a surface railway.

Supposing a train should stick on the track for some reason or other, how are the passengers to get out? For this contingency, provision has been made. The side doors giving access to the cars open inwards, and part of the wall opposite the doors, and additional doors at the end, open outward so that passengers are enabled to step from one train to another. Thus if one train breaks down its occupants may be transferred either to a train on the same metal or one on the opposite track, access from one train to the other being gained by means of platforms which can be lowered when desired. The current supply for the two lines is entirely separate, and as a large battery of accumulators has been put up at the central station, it is extremely improbable that a total breakdown should occur.

The "Piano Player Paradox."

A POSSIBLE EXPLANATION. BY PROFESSOR G. H. BRYAN, Sc.D., F.R.S.

THE invention of labour-saving, or time-saving, machinery is a necessary accompaniment of the advance of civilisation. The performance of difficult music on the pianoforte can only be accomplished with success after months or years of hard practice. The twentieth century has witnessed the invention of mechanical contrivances capable of saving this labour. Such contrivances would be bound to become popular, even if their use were to involve a sacrifice of some of the artistic effects which a skilled pianist is able to produce.

It is commonly supposed that no piano-playing mechanism will enable the player to accentuate particular portions of a chord, the notes of which are all struck simultaneously by a common pneumatic pressure. It appeared to me very early in my experience of these machines that the difficulty might to a large extent be overcome, and I drew attention to the results of my attempts in a letter to *Nature* of December 11. When a number of notes are struck simultaneously on the keyboard of a piano, by means of a pneumatic piano player it *is* possible to accentuate either the bass or the treble end of the chord, and sometimes even its middle notes, provided that the accentuated notes are separated by a sufficient interval from those which it is desired to leave unaccentuated. Almost the whole interest and charm attaching to the use of the new twentieth

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century musical instruments will depend on the power of producing these effects. Without this power the music appears dull and mechanical; with it, but little is lacking from the effects which none but a highly trained professional pianist could produce with his fingers, and if anything appears lacking this *may* not be the fault of the instrument.

What I have ventured to call the "paradox of the piano player," is an effect which may owe its origin to acoustical causes, or it may obtain a purely mechanical explanation in the fact that the hammers of a pianoforte increase continuously in weight from the treble to the bass end of the keyboard, so that the heavy bass hammers require a longer time to be set in motion than the comparatively light ones in the treble parts. It would be very difficult to give a simple discursion of the first hypothesis. The second is, however, much easier to explain with the use of elementary principles alone. To make the explanation more intelligible, it will, however, be better to make certain simplifications in the conditions of the problem, and to take, possibly, an exaggerated case.

Let us suppose then that three hammers of a piano are represented by three masses of 1, 2, and 4 ounces, and that each is released from the action of the key when it has risen a distance of 3 inches. Let us also neglect (for the present) the effects of gravity. Let us suppose in the first instance that each of these masses is acted on by a force of $\frac{1}{4}$ oz. weight. Then by the time the lever supporting the lightest mass has risen its full 3 inches, the state of affairs will be as shown below:—

Time = $\frac{1}{4}$ second.			
Masses	1	2	4
Heights (in inches) ..	3	$1\frac{1}{2}$	$\frac{3}{4}$
Velocities (inches per sec.)	24	12	6

If at this instant the pressure is suddenly cut off, the lightest mass will be projected with the greatest velocity. This mass corresponds to a hammer in the treble of the piano.

If instead of being cut off the pressure is suddenly increased to 2 oz. weight, the state of affairs when the middle mass reaches the height of 3 inches, at which it is released, will be as follows:—

Time from first start $\frac{1}{4} + \frac{1}{16}$ sec. = $\frac{5}{16}$ second.			
Masses	1	2	4
Heights in inches ..	(Free)	3	$1\frac{1}{2}$
Velocities (inches per sec.)	24 (constant)	36	18

If at this instant the pressure be cut off the middle mass will be moving with the greatest velocity. This mass we suppose represents the hammer in the middle of the pianoforte keyboard.

If instead we suppose the pressure further increased to 5 oz. weight, both the lighter masses having been released, the state of affairs when the heaviest mass reaches the height of 3 inches, at which it is released, will be as follows:—

Time from first start $\frac{1}{4} + \frac{1}{16} + \frac{1}{20}$ sec. = $\frac{19}{80}$ sec.			
Masses	1	2	4
Heights in inches ..	(Free)	(Free)	3
Velocities (inches per sec.)	24 (constant)	36 (constant)	42

The heavier mass will now be moving with the greatest velocity. This mass represents the bass hammer of the piano.

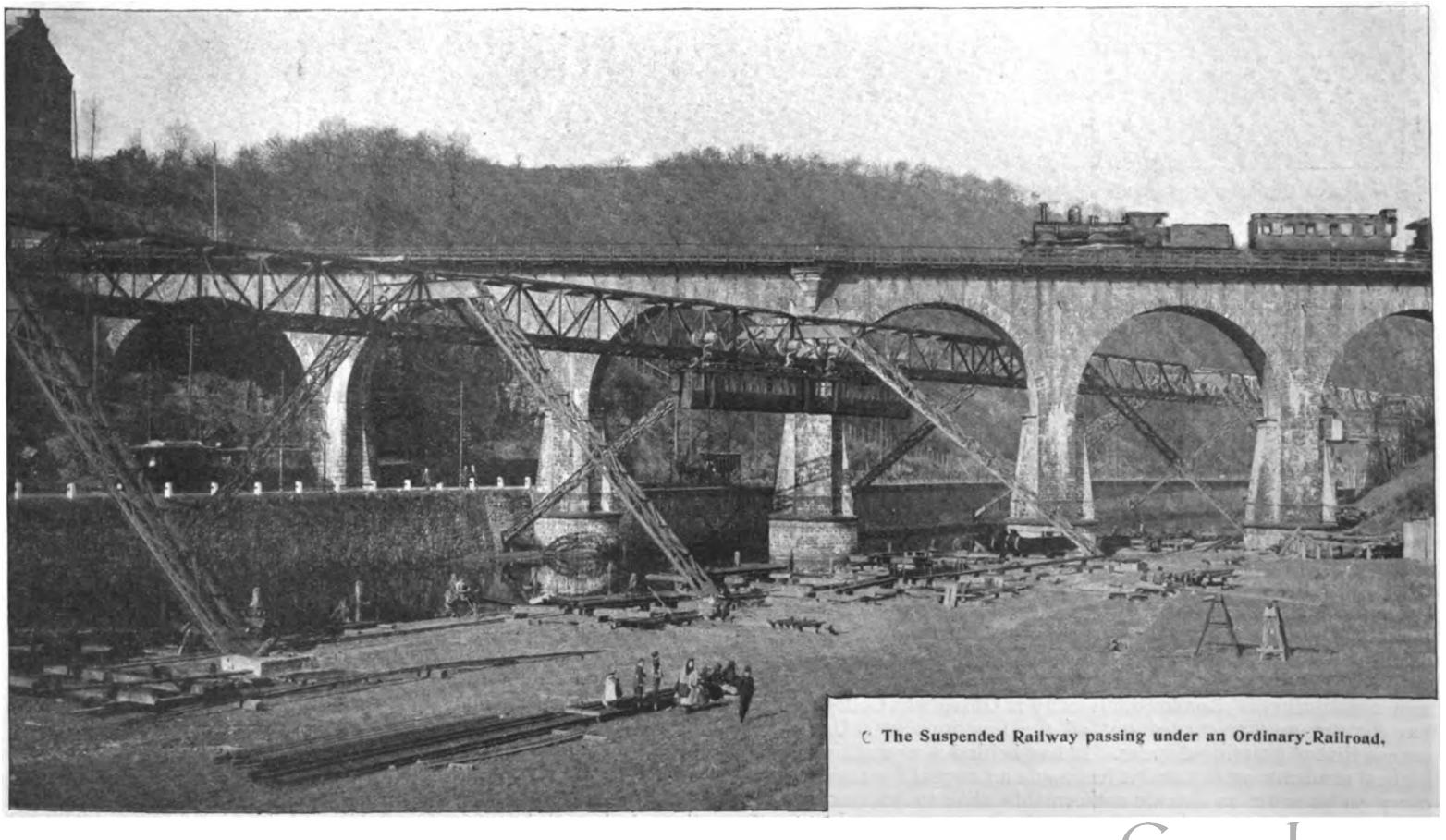
This example shows that either the lighter, the middle, or the heavier mass may be projected with a velocity greater than that of the other two masses provided the common pressure is varied in a suitable manner. It would be easy to construct similar examples with the effect of gravity taken into account.

Those who have a more intimate knowledge of dynamical principles will no doubt consider that the sound produced when a string is struck is not determined by the velocity but rather by the *kinetic energy* of the hammer. This opens up the whole difficult problem of the motion of a struck pianoforte string which has been discussed by Kaufmann in *Wiedemann's Annalen* for 1895 (vol. 54, p. 675). But if the kinetic energy measure is adopted, it is still easy to show that a decreasing pressure will accentuate the treble notes, an increasing one the bass notes; a pressure at first increasing and then decreasing will accentuate the middle notes, and one at first decreasing then increasing will accentuate the end notes, while a constant pressure will now produce a well balanced chord in which the different notes all sound equally loud.

The actions necessary for accentuating the treble and bass notes are to a certain extent comparable with those employed in striking a billiard ball in order to make it screw back or follow on respectively after hitting the object ball. They can be acquired by anyone with a moderate degree of practice, but the amount which can be done in this direction evidently increases with the skill of the performer, so that there is plenty of work for music teachers in the future. It is surprising that effects depending on variations of pressure during a small fraction of a second can be produced at all. The differences are, however, so conspicuous as to attract the attention of a listener who is not expecting them. So far as I know, nobody at present appears to be aware that such effects are possible, and it appears probable that *some* of the piano players now on the market are not capable of producing them.

Wireless Telegraphy.

IN our next issue it is proposed to start a series of articles describing in detail each of the various systems of Wireless Telegraphy. Believing that in the near future this subject will be one of the greatest importance, we think that a complete account of the present position, and descriptions of the various methods now used to transmit and to collect the etheric waves, should prove of considerable interest.



The Suspended Railway passing under an Ordinary Railroad.

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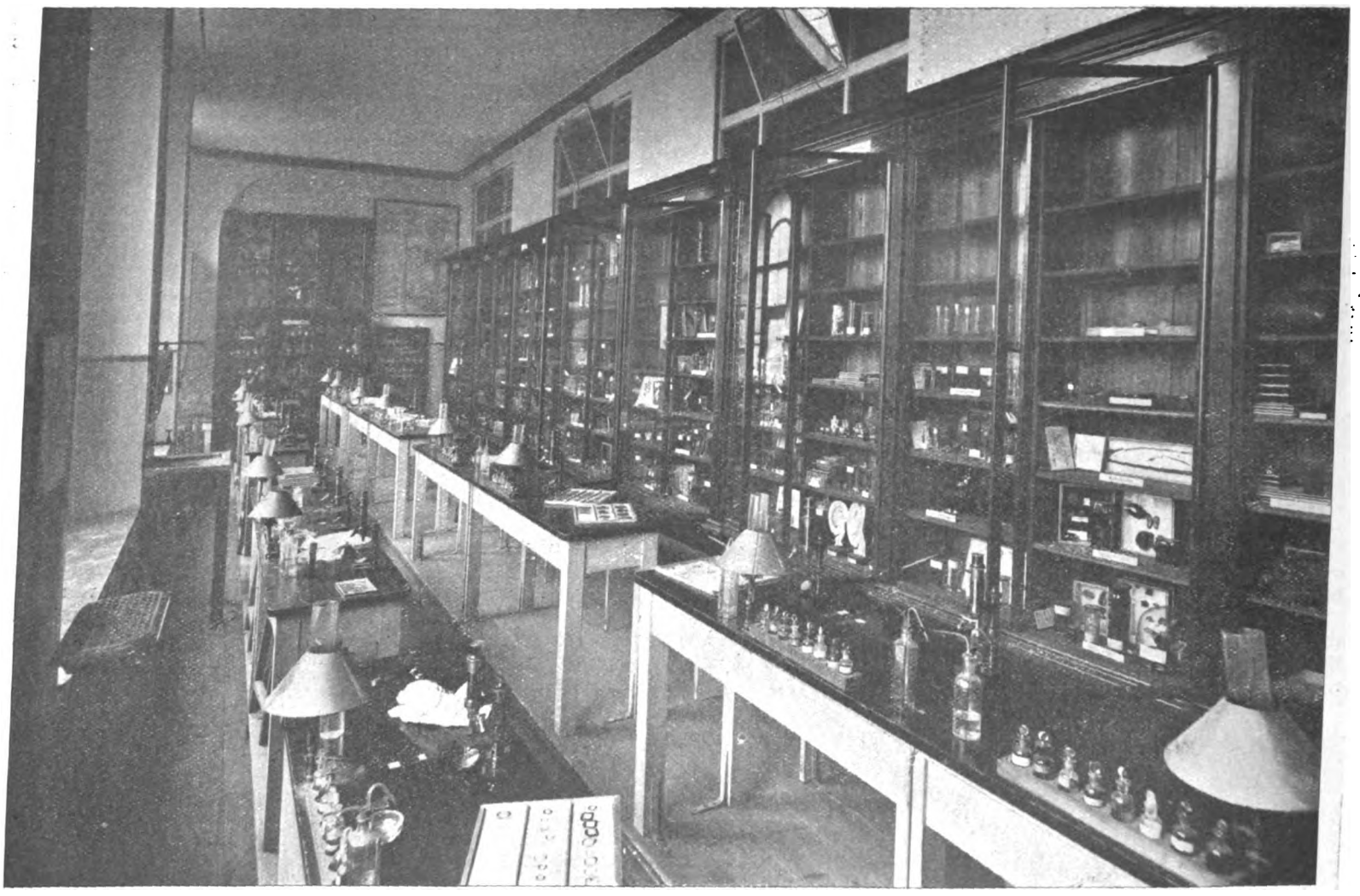
Higher Education and Research.

I. University College, London.

"To my mind, the really appalling thing is not that the Germans have seized this or the other industry, or even that they may have seized upon a dozen industries. It is that the German population has reached a point of general training and specialised equipment which it will take us two generations of hard and intelligently directed educational work to attain." In these words, the President at the last meeting of the British Association gave expression to the thought that has been in the mind of every serious student or professor of science for the last ten years, and upon the lips of some of them for the past generation. The Germans have systematised their system of higher education; and the whole of their Empire has been brought into touch with higher education. In England higher education has too often been conducted on this, that, or the other model without any special reference to the requirements either of the nation as a whole, of industries, or of classes. The result is an assemblage of undirected effort and of conflicting methods in our Polytechnics and Technical Schools. An end to that time and to these methods is approaching. The scientific schools and colleges are consolidating themselves; and one of the most hopeful indications of the new spirit which is spreading in England is the constitution of a Greater University of London, which shall unite in itself the more important and the ablest of the teaching colleges of London. The new London University should be the visible and outward sign of the brain of London. Its establishment will lend encouragement to that endeavour which may plant some day in each great town a university of science, the work of which shall be immediately and prospectively beneficial to the industry of the neighbourhood, as well as useful in the greatest of all ideals, the search for scientific truth.

The foremost of the teaching colleges drawn together by the new constitution of London University is University College, which has for many years carried out all the functions of a University except that of granting degrees. It has behind it a tradition of the highest academic work; and it has made an appeal for assistance to carry on its work on a scale conformable alike to its past achievments and to the new standard of requirements which scientific research sets up. It must always be remembered that scientific teaching, and still more scientific research, must always be carried on at a loss. The student's fees at a college which teaches him Arts and Letters may, though probably they do not, pay for his instruction. In no first-rate scientific college in the world do they ever do so, even if the preliminary outlay for buildings, laboratories, and apparatus be left out of the account. Consequently, if ever a college can be shown to be doing good work, it may be taken for granted that it is doing it at a loss; and that this loss is only too often the time, brains, energy, and pocket of inadequately paid teachers and professors.

To come to the statement of the scientific work done at University College. The departments are Chemistry, Physics, Zoology, Botany, Geology, Anatomy, Physiology, Pharmacology, Pathological Chemistry, Pathology, Medical Jurisprudence, Mechanical Engineering, Electrical Engineering, Mathematics, and Astronomy. These are teaching departments, to the work of which we shall refer more particularly presently. But it is at least equally necessary to lay stress upon the original scientific research carried on in them. In the last ten years 127 original papers have emanated from the faculty of Chemistry, describing investigations and original researches which have embraced the discovery of Argon (Professor Ramsay and Lord Rayleigh) and the isolation and examination of the rarer gases of the Earth's atmosphere. In Mathematics, thirteen papers, and in Applied Mathematics, the department in which Professor Karl Pearson has conducted invaluable researches in Heredity, sixty-five papers. Geology and Mineralogy, under Professor Bonney, have contributed sixty-four papers; Physics, in which Professor Callendar's high temperature thermometry is conspicuous, twenty-four; Pathology, forty-two papers; Pathological Chemistry, thirty-seven. Eighty-three papers have come from the Animal Physiology section, and forty-three from that of Zoology. Beyond these older departments there are others in which investigation has of late years received new impetus. Among them is the department of Botany, which, under the direction of Professor F. W. Oliver, is responsible for most interesting and important discoveries in Fossil Botany; and this department has a journal of its own, *The New Phytologist*, edited by Professor A. G. Tansley. Electrical Engineering has, under the direction of Professor Fleming, won a high place for University College in research in this science of mutable methods; and good work has been done also in the sciences of Hygiene and Mechanical and Civil Engineering. These last-named sections have all their yearly output of original papers. In the ten years the output of all the scientific sections has reached the number of 684 papers, an average of nearly seventy papers a



University College—The Botanical Laboratory.

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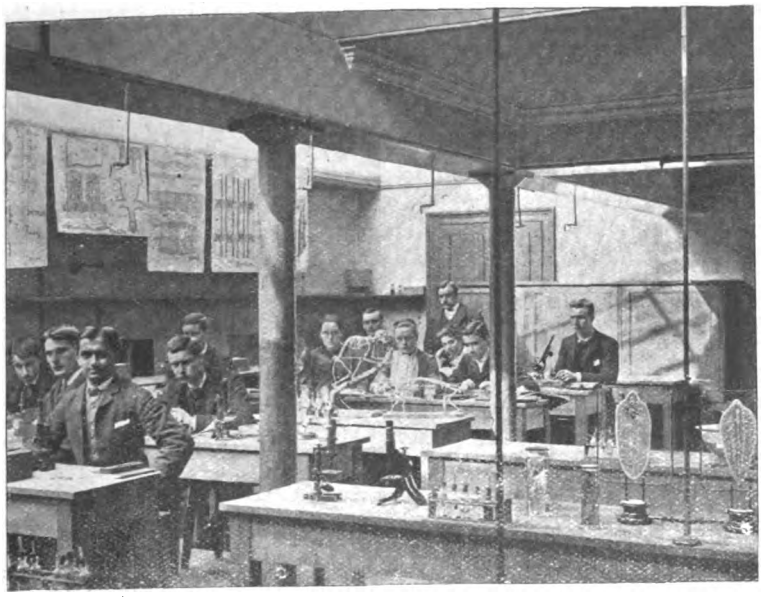
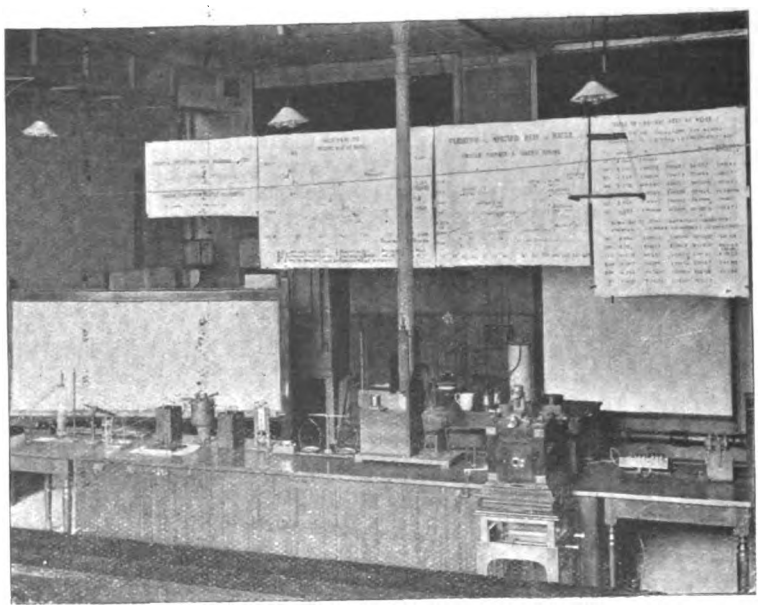
year. The average is rising, and last year more than eighty original papers were produced.

Some of these departments have a long and honourable history; some are of recent growth and development. Of the latter kind are the Engineering departments, with the new Electrical Engineering Laboratory, and the Botanical Laboratory. But from the youngest to the oldest there is hardly one that does not stand in need of expansion. The new Electrical Laboratories are rightly regarded with approving pride by those who direct them and by those who work in them. The opportunities they afford for experiment are evident from the variety of appliance with which they are equipped; and the latest developments of polyphase working, of electrolysis, and of telephony can be studied side by side with the theory of electric induction and of electric vibrations. Nevertheless, to quote a sentence of Professor Fleming's, "Enormous as has been the growth of electrical industries already, it is certain that we are as yet only at the beginning of their development. . . . It cannot be doubted that the advance in the practical employment of electricity will be even greater in the next twenty years than in the last, but the share of this country in the coming advance will depend on the education of its young engineers, and their capacity for dealing intelligently and effectively with the new problems that are continually arising. . . ." This means that even the newest of engineering laboratories must be continually expanded and altered. Progress is too rapid for even the most comprehensive knowledge of the methods that have been found effectual in the past to be of much service.

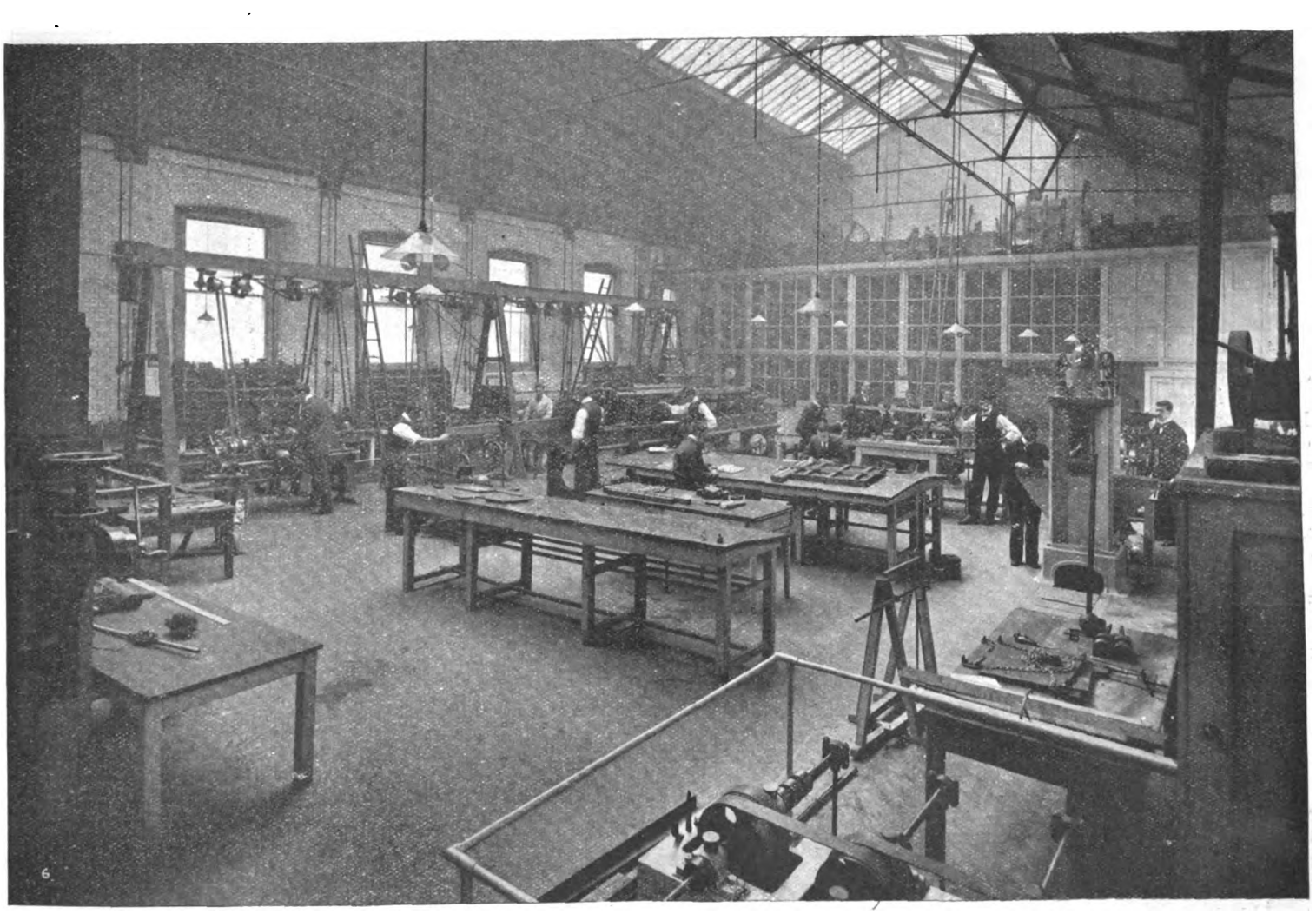


University College—The Zoology Class.



University College—The Physics Theatre.

Development, and the need for development, is making itself felt in every science, in every laboratory. Botany may for instance serve as an useful text on the actual development of a science in comparatively recent years. At the time of the establishment of University College, Botany occupied a position in the academic curriculum very different from that accorded it at the present day, it was regarded chiefly as a necessary preliminary to the study of Materia Medica for medical students. Until about 20 years ago instruction in Botany was almost entirely confined to the lecture-



University College—The Engineering Laboratory.

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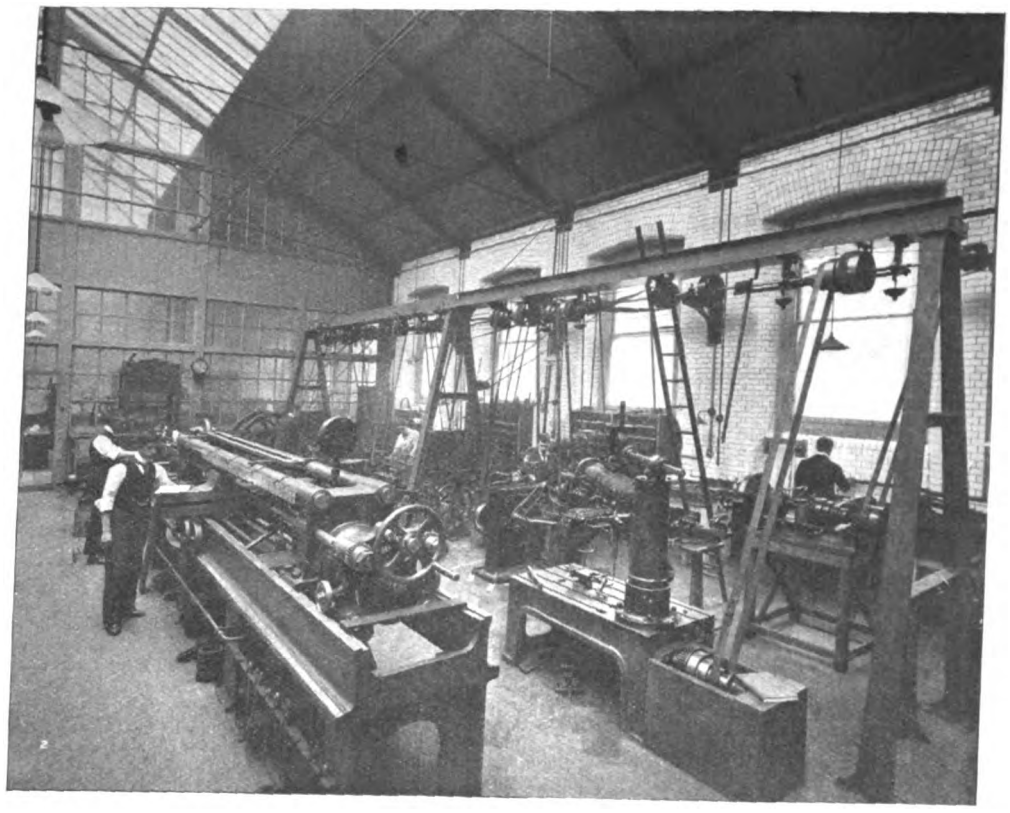
room. In 1879, definite laboratory courses were established under the supervision of F. Orpen Bower, and at the present time Botany, with its subdivisions into systematic, physiological, and morphological botany, is a serious pursuit, of equal rank with the older sciences of Physics and Chemistry and necessitating the continuous activity of a number of specialists. Indeed one of its departments, Bacteriology, has been elevated to the status of a separate science, so great and important are its bearings on industrial processes as well as on disease. The knowledge of the life-history and vital processes both of the higher and lower forms of plants has proved and is proving of greater economic importance every day in the arts of forestry and agriculture. There are laboratories, crowded and busy, at University College; but into them are packed half-a-dozen branches of research. Laboratories are required, specially fitted for research into the physiology and morphology of plants, including the increasingly important branch of palæo botany, while



University College—The Engineering Workshop.

space is needed for herbarium collections, as well as for the proper display of the rich collections already possessed by the department.

What is true of these two typical departments is true of all. Room for expansion, facilities for research, opportunity for an increase in the number of workers, more teachers, is the cry that goes up from them all. The appetite for good work comes in doing it. Opportunity to conduct the "minutiæ that make for success in modern chemical research" is asked for by the Professors of Chemistry; capable teachers to undertake the greater portion of the elementary work, so that the heads of departments should be able to devote the greater part of their time to research and to the superintendence of research, the work for which they are fitted by their special attainments—that is what the Physics department asks; and these two demands commingled are the keynote of the needs of University College; and in a larger sense of higher education in England.

E. S. G.

Energy and Heat.

WHEN a body is giving out heat, its molecules are vibrating; and the discovery that heat was molecular vibration supplied the missing link in the theory of the "conservation of energy." Energy never disappears. It is sometimes converted into heat. When Joule made his first experiments to show that there was some definite mathematical relation between heat and work—that is, a given amount of the mechanical motive ought to produce a definite amount of heat, and *vice-versâ*—his ideas were so little understood that the demonstrations were refused a place in the transactions of the Royal Society for seven years. Joule, however, was young, and he lived to attend the funeral of all his detractors. Since his day the "mechanical equivalent of heat," as he called it, or to put it the other way round, the "thermal equivalent of energy," has been the subject of close observation and minute revision. A lecture delivered last week by Principal Griffiths at the Royal Institution gave an illuminating description of the refinements of the measurement by which the relations between heat and energy are reached. Joule's equivalent was, roughly stated, that 772 pounds falling one foot under the influence of the gravity would heat a pound of water one degree. Later investigations have shown that 778 lbs. is nearer the truth than 772, but these figures give but little idea of the exactness at which the investigators aim. The relation, as expressed by Professor Callendar's latest determination, is as follows:—The erg is the unit of work, and is defined as the work done by a force of one degree while moving through one centimetre—a degree being the force which will give to a mass of one gramme an acceleration of one centimetre. The action of gravity would give to a mass of one gramme an acceleration of 981 centimetres. Taking these as our constants, we find that $4{\cdot}181 \times 107$ ergs is the amount of work necessary to raise one gramme of water one degree of heat. Joule found the figure to be $4{\cdot}173 \times 107$, a considerable discrepancy.

The Blood Test.

IT is sometimes still asserted, usually by novelists, that there is no test for human blood, which can be depended on, though Mr. Sherlock Holmes was said to have found a chemical test. In a recent murder trial at the Old Bailey, the Counsel for the Crown daringly assured the Jury that it was not possible to distinguish human blood stains from those of other mammals; it was possible only to say that the blood generically was mammalian blood. This statement entirely ignores the delicate and conclusive test which bacteriology has supplied. If the blood of an animal be infected with some foreign body, it takes steps which may be final to destroy or nullify that body, sometimes by killing it, sometimes by dismembering it, sometimes by agglutinating its parts. And if the blood be slowly infected with moderate doses of the foreign body, then a "blood serum" is formed which will always agglutinate the specific foreign body, but will agglutinate nothing else The blood serum is a specific agglutinator of the specific intruder. Now for the test. Rabbits are kept which are separately subcutaneously injected with the serum of human blood. The rabbits' blood then gradually produces a serum reagent which will always agglutinate human blood; and this serum reagent can be kept active for some months if preserved at a low temperature. When it is required to test a blood spot, the spot or stain is dissolved in water, and two or three cubic centimetres are put in a test tube. Similar test tubes hold solutions of apportionately the same strength, which are made from the blood of oxen, sheep, pigs, dogs, &c. To each of these solutions is added ten drops of the serum reagent, and the mixture is raised to about 40 deg. C. The test tube, which contains human blood, if human blood it be, will in ten minutes form a precipitate in bulk, and this precipitate, the "agglutionism," will be fully deposited in half an hour. None of the other kinds of blood will exhibit any precipitate within half an hour, though they may show a very slight one after that time. Even old blood stains may be recognised by that means.

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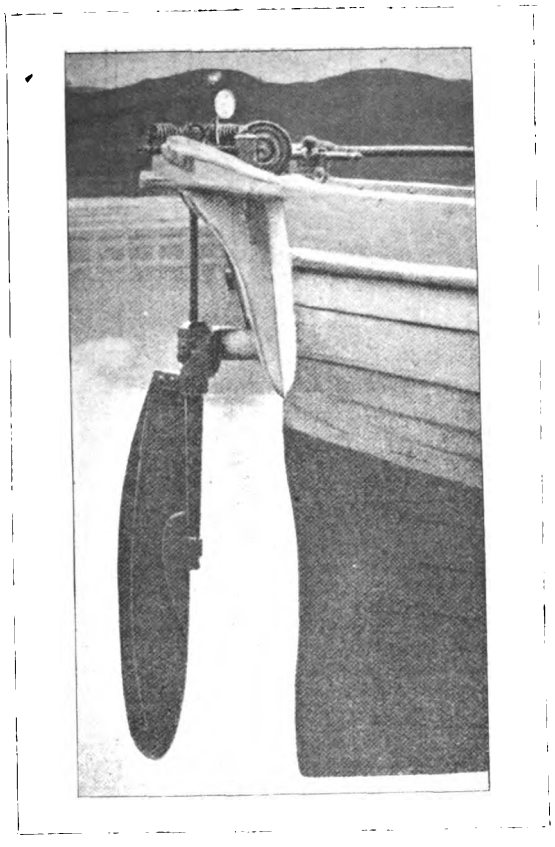
The Pendulum Propeller.

Some Interesting Experiments.

THE subject of screw-propellers is one that is attracting the attention at the present time of naval architects, shipbuilders, and marine engineers all over the world. The recent contract trials of the *Drake* and *Monmouth* classes of cruisers have proved that the question as to which type of propeller is best fitted for each type of vessel is by no means settled, though it is agreed that every type of ship requires its own particular form of screw. H.M.S. *Drake*, on her first eight hours' full-power run, with the propellers originally made for her, made a mean speed of 23·05 knots, her engines indicating 30,557 h.p. It was then decided to fit experimental propellers with a very much greater ratio of surface to diameter, and the result was that *with the same horse-power* she made a mean speed of 24·11 knots in four runs over a measured distance and 24·96 knots on her best run, thus increasing her speed by 1·06 knots. The new pattern *Drake* propellers are to be fitted on her three sister vessels, the *Good Hope*, *Leviathan*, and *King Alfred*.



The Propeller.

As to the county cruisers, the *Monmouth* class, the *Kent* and *Bedford*, the only two which have so far run their trials, have each failed to reach the contract speed of 23 knots. The *Bedford* on her eight hours' full power run produced 22,457 horse-power, but not more than 22·7 knots could be got out of her. The *Kent* on her first trial made 22,880 i.h.p., with a speed of 21·7 knots only. The Admiralty then ordered the pitch of her propellers to be altered from 19 ft. 6 in. to 20 ft. 6 in., but the result was still unsatisfactory, as with her engines developing 22,526 h.p., she only made 21·89 knots.

Experiments are now being carried out by the Admiralty officials with the view of increasing still further the speed by the substitution of an improved form of screw-propeller. The latest reports state that as the result of polishing up the hull and propeller blades, her speed has been improved, but only by three-quarters of a knot.

The question as to whether the propeller now universally in use is the best fitted for ships' propulsion is one that has exercised the minds of many inventors, amongst whom is Mr. H. C. Vogt, a Danish engineer, who has devised the "Pendulum Propeller," and has carried out experiments with vessels fitted with this novel arrangement.

The rudder or driving blade D shown in the illustrations possesses double harmonic motion by means of the arm T. United firmly to and projecting downwards from the main rocking shaft A, it can be oscillated like a pendulum in a vertical plane, and the consequent water pressure against the rudder will then again oscillate it around T itself, one way or another, according to the direction of swing of the arm T, which, being perforated, forms a bearing for the rudder stock or shaft *t*, which is firmly secured to the rudder, and furnished with a universal joint *u* opposite the axis of the main shaft A. The part played by the universal joint *u* is most important, because it permits the rudder-stock *t* to swing, while the oscillation of the rudder around T is transmitted by means of *t* and the universal joint *u* to the vertical manœuvring shaft t^1, from the top of which springs F combine t^1 with a horizontal steering wheel R. The springs are strained and unstrained, on receiving and returning energy, in accordance with the oscillation of the rudder around T, producing that peculiar fanning motion whereby the ship is driven. The manner in which steering is accomplished, contemporaneously with forward speed, can readily be gathered from the figure.

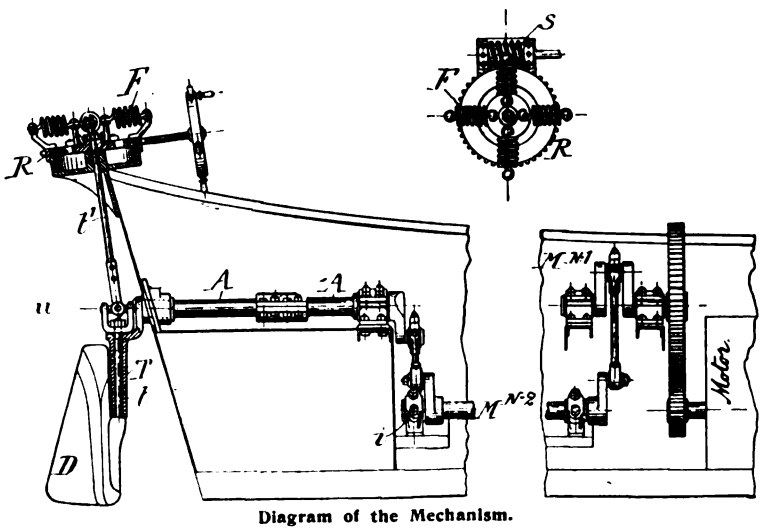


Diagram of the Mechanism.

So far back as 1888 Mr. Vogt began a series of trials in Copenhagen with the pendulum propeller driven by manual power, and he states that he found it was more efficient than an oar. In 1898 steam power was substituted, and in 1900 trials were made with a launch fitted with a one b.h.p. petroleum motor.

It was found that the driving thrust of the pendulum propeller was 25 per cent. greater per effective h.p. than that of the ordinary bronze screw propeller originally fitted. At 300 revolutions of the engine, corresponding with 120 double swings of the propeller, a thrust of 92·4 lbs. was found, or 72 lbs. per effective h.p. Mr. Vogt states that under the same conditions a thrust of more than 55 lbs. per effective h.p. is rarely found with any screw propeller. Near the surface of the water, where the wake follows the ship with the greatest speed, the speed of the upper part of the driving blade of the pendulum propeller is slow; the increase in resistance is therefore of no consequence, whereas it is considerable with the screw propeller. Mr. Vogt explains the higher efficiency of his propeller by stating that it acts upon some 30 per cent. more water; that its elasticity enables it to accelerate the water gradually, and that a subsequent stroke takes up a great part of the lateral energy given to the water by a previous stroke, and that the manœuvring ability was greater than that attainable by twin screws and helm together, on account of the greater leverage between the propeller and the centre of turning of the ship.

Subsequently to these trials, the Russian Admiralty fitted the pendulum propeller to one of the launches of the fast Russian cruiser *Bojorin*. The launch's dimensions were: Length, 31 ft.; beam, 7·7 ft.; draught, 2·5 ft. It was driven by a 16-h.p. benzine motor of German make, giving 750 revolutions per minute.

The pendulum propeller proved itself to be capable of higher speeds and greater manœuvring power than the same launch fitted with a screw propeller.

Mr. Vogt was led to devise his pendulum propeller by studying aquatic animals. All of Nature's propellers he found possessed double harmonic motion. The tail of a swimming animal must

The Pendulum Propeller Boat Under Way.

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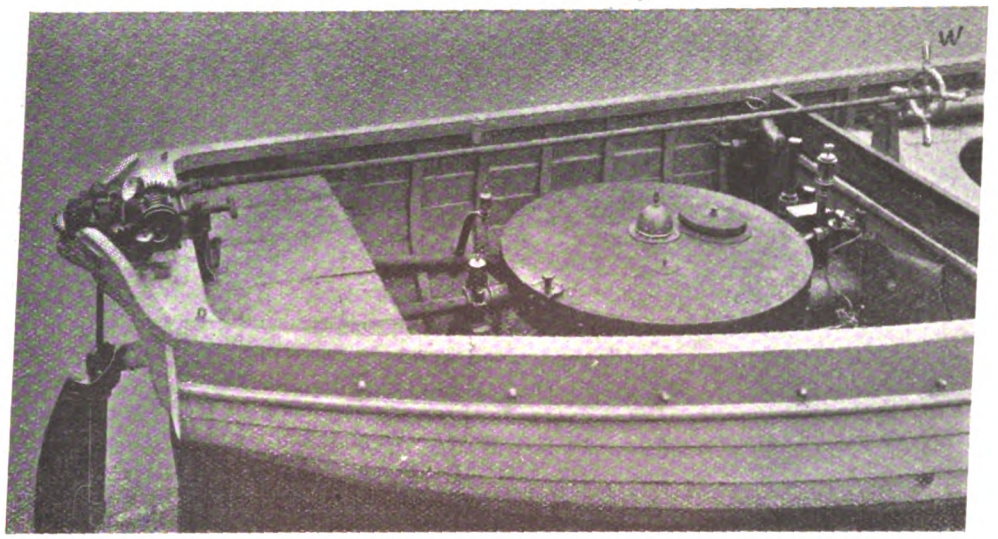
possess sufficient area to act on the water, and to avoid losing power this area is bound to oscillate in accordance with the laws of harmonic motion. In designing the pendulum propeller his aim was to act directly upon a very much larger body of water than was possible with the screw propeller; by means of springs, the loss of energy caused by sudden changes in the velocity of the fluid acted upon is greatly reduced, and by means of the oscillating motion a perfectly new body of water is acted upon, and accelerated at each new stroke. The pendulum propeller acts both as driving-screw and rudder.

The Russian experiments proved that, so far as the little launch was concerned, the efficiency of the pendulum propeller was superior to the screw, the power in both cases being the same. With a better engine, and two pendulum propellers working symmetrically against each other, Mr. Vogt claims that the efficiency would probably have been 30 per cent. higher; and he says that the conditions



View of the Pendulum Propeller and Mechanism from above.

are much simpler with larger and slower working propellers, because the regulation of their pitch by means of the springs is much easier when the period of oscillation is great than when it is small.

For instance, in a merchant ship of 1,200 tons displacement, two pendulum propellers, each 12·5 ft. long, would be most suitable. Mr. Vogt says that the effective work of a merchant steamer with single screw is not more than 37 per cent. of the indicated power.

It is to be hoped that further experiments will be made with this invention on larger vessels than those on which it has up till now been applied. When one remembers the condemnations that were passed on the screw-propeller when it was originally suggested as a more efficient agent of propulsion than the paddle-wheel, one naturally hesitates to pass any very decided opinion as to the future of any innovation until it has received careful attention from scientific men, and has been thoroughly tested.

Music of the Spheres.

THERE are several systems of wireless telegraphy in existence of which that of Mr. Marconi is best known. His system is that of transmitting Hertzian waves. But the first practical system of wireless telegraphy, which was set up by the British Post Office, consisted of parallel circuits of wires, in which a current sent through one wire induced magnetically a current in the parallel wire. Sir William Preece, while at the Post Office, attempted to establish telegraphic communication between England and Ireland by joining great parallel circuits from North to South of Ireland, and from the North to the South of England. The endeavour to set up induced currents was a failure, the experiment produced strange and inexplicable sounds in the wires and in the telephones joined up to them, sounds which Sir William Preece attributed to extra-terrestial magnetic disturbances, and which might be due, he thought, even to solar disturbances. Sir Oliver Lodge has been giving some attention to similar phenomena, and in a communication to the Royal Society, describes sounds which he has heard in the telephone receivers in experiments in inductive wireless telegraphy. These sounds are far removed from the usual inductive influences. They are stronger in summer than in winter, and strongest about sunset. They may be divided into noises resembling (*a*) uniform flowing or rushing of water, (*b*) intermittent crackling, (*c*) bubbling and boiling of water, (*d*) rocket disturbances, and (*e*) high frequency disturbances inaudible in the telephone, but evidenced by the coherer or other detector. The rocket disturbances commence with a shrill whistle and die away in a note of diminishing pitch. They are probably due to meteorites rushing through the atmosphere and producing electric disturbances of diminishing frequency as their velocity decreases. They are more usually observed at night time, not because meteorites are more frequent then, but because in daylight the highly ionised air screens the effect by absorption. At nightfall the day ionisation disappears and the clearing-up is accompanied by the noises described.

Constituents of the Atom.

Electrons and Matter.

IN the address which Sir Oliver Lodge recently delivered to the Institute of Electrical Engineers, and which has now been reprinted in their "Journal," he stated with inimitable clearness and force the electric theory of matter. It is impossible in the space at our disposal to go with him through the whole length of this new chapter in the modern views of electricity, but by following him in the abstract of his own lecture which he delivered before another audience, we may, perhaps, succeed in presenting in an abbreviated form some of the views he expressed.

There are certain fundamental properties of matter—cohesion, gravitation, inertia. The second

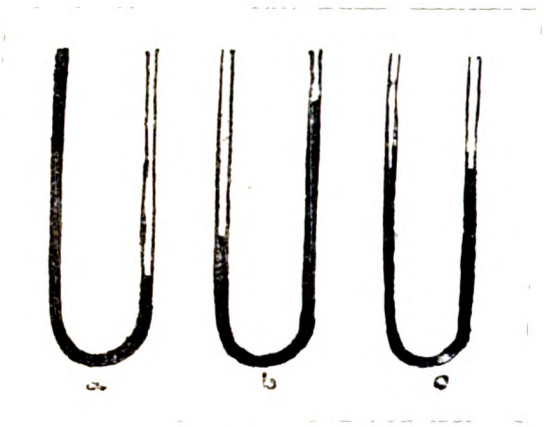


Fig 1.

of these, gravitation, is, as a term, known to everybody. Everybody knows that bodies have weight; that bodies attract one another—very slightly; though when the body is great, as in the case of the earth, the results of the attraction are very evident. But these observed facts are merely empirical facts; we do not know why bodies attract one another, and so far as we can see at present, there is little chance that the reasons will become known. Of the other fundamental properties, cohesion, by virtue of which the constituents of a body cleave together, cohere, is now weakening in the resistance which it has offered to our comprehension and is yielding up its secret. There remains "inertia." What is inertia? It can be defined as the "power of overshooting the mark" or the "power of moving against force." When a bullet is fired from a gun it is at first, while in the gun barrel, being pressed forward by the gases in the barrel. When out of the gun it still goes forward, though no longer pressed forward, but, in fact, pressed back by the resistance of the air. It goes forward by virtue of its inertia. A pendulum after passing the lowest point of its arc moves upward—inertia again. If a liquid be situated in a U-shaped syphon tube as in Fig. I. (*a*) and then be allowed to fall by suddenly removing the plug at the top of the left hand branch of the U, and so allowing the pressure of the atmosphere to act, then the liquid will do more than fall to an equal level in either branch of the tube. It will rush up beyond its proper level in the right hand branch of the tube; and several oscillations of the liquid on either side will take place before it comes to rest as in position *c*. Thus the property of inertia which the liquid possesses gives rise to oscillations. Now oscillations of this kind occur in electricity. There are rapid changes from positive to negative, and some years ago we should have said that electricity had a property resembling the inertia of matter—that there was in electricity a mechanical analogue to the oscillations of matter. Sir Oliver Lodge now tells us that electricity has real inertia, actual inertia; that there is no inertia but electrical inertia. And that the inertia of matter must be explained electrically.

Now, paradoxical as it may appear, we know more about electricity than we know about matter. We do not understand the inertia of matter. We are accustomed to the inertia of electricity; and the phenomenon in electricity which is anologous to inertia we call self-induction. By the law which Lenz formulated, a change in an electric current such as may be described as an increase in the strength of the current calls forth an antagonistic force. This is a property exactly anologous to inertia. Sir Oliver Lodge now tells us that it is inertia. It is only brought out in the case of an accelerated force. Now what is a current of electricity? An electrically charged body in motion; for convenience of thought we will say a charged sphere in motion is an electric current. There is no other electric current. A current is surrounded by magnetic lines of force. A series of concentric circles of force surround the moving sphere—the current—and this is the magnetic field. There is no other kind of magnetic field. A cannon ball charged with electricity and fired would be an electric current. It would produce an electric field—a very weak one, but not differing in first essentials from any and every other magnetic field. Now therefore let us consider the three states of electricity. There is the charged body; at rest it

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gives us an electro-static condition; in motion it produces magnetisation. In accelerated motion it gives us the phenomena of radiation (or light) and inertia. There is no kind of radiation (or light) except that due to the acceleration of a charged body. And probably there is no other kind of inertia except that due to the acceleration of a charged body.

According to Professor J. J. Thomson, who investigated the properties of a moving charged sphere, of radius a and charge e, the inertia is proportional to the square of the charge and inversely proportional to the radius of the sphere

$$m = \frac{2\mu e^2}{3a} = Q.V$$

μ being the ordinary magnetic constant. Thus inertia is proportional to the quantity and potential.

Now this is true, even if the charged sphere be reduced to the size of an atom. The added inertia is still insignificant compared to the whole, though it becomes comparable to the whole. It is perhaps the $\frac{1}{100,000}$th part of the whole. Thus if the atom considered as a piece of matter be regarded as 100,000 inertia units then when electrically charged it will have, say, 100,001 units.

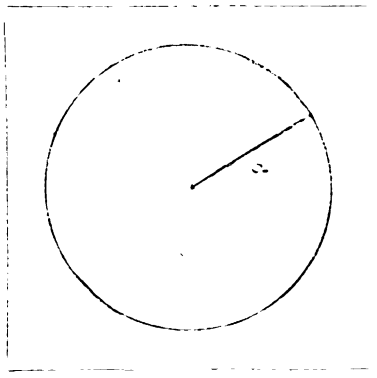

Fig. 2.

The inertia given to it will therefore not be readily detected. When the mathematical equivalent of inertia was thus first made out, the atom was considered as the limit of matter, and inertia was regarded chiefly as a mathematical curiosity. But Sir William Crookes, in 1870, in drawing attention to the particles which flew from the cathode to the anode in Crookes tubes, suggested that here we had particles of matter in a fourth state—neither gaseous, liquid, nor solid—and that these particles were fragments of matter, ultra-atomic corpuscles. They were the foundation stones of matter. The suggestion was at first disbelieved, almost ridiculed. But gradually the theory was supported by an increasing volume of testimony; and the belief grew that all atoms of matter may be composed of the same particles. To these particles Dr. Johnstone Stoney first gave the name of "electrons." It is the name belonging to the charge of the electric ion (the ion is the name given to the atom plus the charge). Here again we must pause to consider how a charge travels. In a liquid, charge and atom travel together until the solid electrode is reached—this is what Sir Oliver Lodge calls the bird-seed method, the atom carrying the charge as a bird carries a seed. In a gas this is not so. The charges are knocked off, they are disembodied charges—electric ghosts. It is possible to measure their mass and their speed also. It would take a century to collect a measurable quantity, say, the thousandth of a milligramme. But a gramme of them travelling at the speed of light would still have considerable energy, enough, for instance, to lift the British Navy to the height of Ben Nevis.

The size of the electron is known on the hypothesis that the atom of matter is composed of electrons. Into the evidence that this is the case, we have hardly space to go within the limits of a single article; but by reversing the formula quoted above we have

$$a = \frac{2\mu e^2}{3m}$$

and the broad conclusion reached may be stated by saying that an electron has a diameter $\frac{1}{100,000}$th of the diameter of an atom. The disproportion between the size of an atom and the size of an electron is vastly greater than that between the sun and the earth. If an electron is depicted as a speck one-hundredth of an inch in diameter, like one of the full stops on this page for instance, the space available for the few hundred or thousand of such constituents to disport themselves within an atom is comparable to a hundred feet cube. They are, in short, like a thousand full stops in a church 160 ft. long, 80 ft. broad, in which the dots therefore would nearly be lost. And yet on the electric theory of matter they are all of the atom that there is. They "occupy" its volume in the sense of keeping other things out, as soldiers occupy a country; they are energetic and pushful, though not bulky, and in their mutual relations they constitute what we call the atom of matter. The atom with its electrons may be compared to a complicated astronomical system much like a nebula, with no sun, but with a large number of equal bodies possessing inertia and subject to mutual attraction and repulsion in place of gravity.

The fate of the Oyster.

Of late the attention of the public at large has been attracted to the question of shellfish as a food supply, and in particular to oysters. For precisely how long the cultivation of the latter has been undertaken, we cannot without reference to a work on the subject state; but it is a fact that the industry has increased by leaps and bounds, and has thriven vastly, for your Londoners, and your Britisher, wherever he be, finds the bi-valve a toothsome morsel, and is prepared to pay a high price in order to gratify his palate. Not only in England, but on the Continent, in India and in many other places, oysters form an article of food, common and inexpensive it may be, and therefore not considered a luxury in one portion of our sphere, and decidedly an expensive dish elsewhere.

But a question has arisen as to the safety of the bi-valve, and though it has occupied the attention of the Local Government Board and the Fishing Guild for some years, it has never perhaps attained such importance, nor attracted the attention of the public as during the past few weeks. A sudden outbreak of enteric fever at Southampton and in the neighbourhood has brought the subject into prominence, for it is stated that many of the cases are due to the consumption of oysters at a mayoral banquet, the same having been obtained from the Emsworth beds. A great outcry has arisen, and very rightly so, that there should be some form of legislation to protect the public. We have a Food Adulteration Act, and why not one which has for its aim the closing of the markets to all oysters which are not absolutely and totally above suspicion? And with the latter must be classed winkles and other forms of shellfish, habitually partaken of in an uncooked state by the people inhabiting these isles.

That something should be done, and done quickly, is of vital importance, but it behoves those who have to deal with the subject to pause and consider carefully at what target their shafts shall be aimed, and whether an Act making it imperative that all oyster beds should be protected from possible contamination with the bacillus of enteric fever could be effectively carried out.

Let us investigate the cause of contamination, and then, having discovered it, proceed to apply a remedy, for it is foolish and obviously unfair to call upon the purveyor of oysters to go to vast expense in search of a preventative, when the source of all the trouble is beyond his jurisdiction.

Now, what are the facts? Tons and tons of sewage are discharged from our coast during the year, and in many cases the fluid mass is absolutely untreated. Too often the outfall consists of the products of a town and the neighbouring districts, collected perhaps in storage tanks to await a propitious movement of the tide, and then allowed to flow out to sea, where its black, noisome course can frequently be followed by the naked eye. Indeed, being of a different density to the sea water—as an observer states in this week's *British Medical Journal*—it fails to mix with it readily, and passes on its solitary course, just as a river will sometimes flow through an inland lake without mingling with its waters.

Does the brine kill the bacillus of enteric fever? This question can be answered in the negative, without producing further evidence, for otherwise this important subject would never have arisen, and oyster eaters would never have had cause to pause in doubt before partaking of the delicacy. Washed hither and thither, and split into minute particles, the sewage matter is either carried out to sea and slowly disseminated, or it is washed along the coast line, settling upon rocks, seaweed, &c., as a filthy deposit. Go to any coast town, and inspect the neighbourhood of the sewage outfall, and this condition will frequently be observed.

Having safely and expeditiously got rid of their sewage, the Corporation of most towns are sufficiently satisfied, feeling that they have overcome a matter of no small difficulty, and thereafter, no doubt, give very little thought to others who may inhabit the coast. But what of the fishermen? What of the shellfish industry? How can the most carefully arranged and protected oyster bed close its gates to this sewage? Is it not possible, probable indeed, that as wreckage floats along the shore, swept by the wind and tide, so are particles of untreated effluent able to make their way from one portion of the coast to another in a similar fashion? Perhaps for a period the bacilli are innocuous, consisting of the coli communis variety, and of others; but there comes a day when the enteric bacillus, set free from some seaport town, as the result of a case amongst the inhabitants, finds its way to the oyster beds, where a bi-valve greedily absorbs it. In turn the fish is gathered and dispatched to the market, and—another case of enteric has to be notified.

Under the circumstances, how can any act deal effectively with the question which does not go to the very root of the evil? If we come across a case of infectious fever, we rigorously isolate it, so that others shall not suffer. Then why should we not do the same with this enteric bacillus? Is it reasonable to allow the discharge of such a dangerous enemy into the ocean, well knowing that the danger is always present, that the infection may return to mankind in one of the largest and most important of our food supplies?

After all, the remedy for this evil is an easy one, and, as is pointed out by a correspondent in the *British Medical Journal* could be

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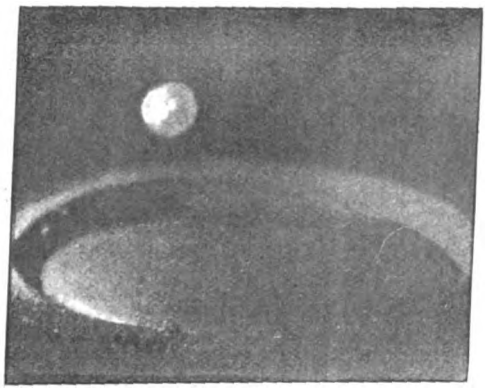
attained without great expenditure or trouble. Instead of calling upon the fishing guilds and oyster cultivators to do the impossible, it should be made illegal to pass untreated sewage into the sea. Numbers of seaport towns have already brought themselves abreast of the times, and have erected "septic" tanks, in which all harmful bacilli are quickly reduced to the apposite condition, and from which a perfectly innocuous effluent is finally allowed to escape. The process is no more costly than the one formerly in vogue, and still, unfortunately, retained by some corporations. The tanks would have to be provided, and the outlay would be so small that there is no doubt that it should be at once incurred, not alone for the sake of the oyster-loving public, but because the old method is dangerous in other ways. Again, why should the effluent be discharged into the sea at all? This last question opens up a large field for discussion, but we will remind our readers that sewage has its value, and that its aid to agriculture is considerable.

The Splash of a Projectile.

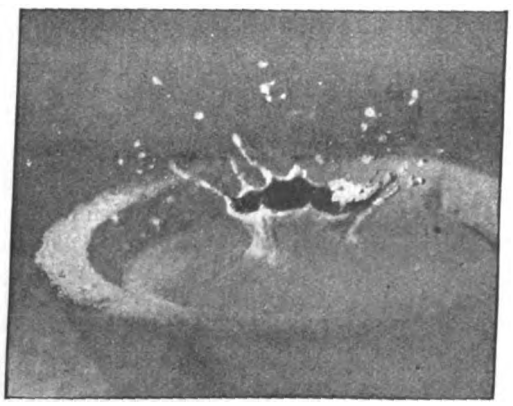
THE accompanying series of photographs were lent some years ago by the late Sir William Roberts Austin, the most brilliant of English metallurgists, to the writer, and they illustrate the resemblance of the splash of a drop of liquid to the splash produced by a shot from a gun when it impinges on steel armour plate. "Even in the case of metals," said Sir William Roberts Austin, "the three states of matter—solid, liquid and gaseous—merge imperceptibly into one another, for even in a solid metal some molecules retain the freedom of motion, characteristic of a gas. It is easy to show that the behaviour of a solid metal may closely resemble that of a fluid



The Bullet falling into Molten Gold.

one, and that a fluid metal in turn shares the properties of an ordinary non-metalic fluid."

Some time before Sir W. C. Roberts Austin's experiments, Professor Worthington had obtained photographs of the splash of a drop, such as might be produced, for instance, by a marble falling into a bowl of milk. The Chemist of the Mint replaced milk by molten gold. It is unnecessary to dwell on the difficulties of manipulation, though they were very great, for, firstly, gold molten in a crucible had to be kept from freezing. And gold freezes or solidifies at 1062 degrees centigrade. Secondly, the light emitted from the



The Splash of Molten Gold.

surface of the molten gold is continuous, and while it is not sufficiently brilliant to enable the gold to be photographed without another illuminant, it emits enough light to fog the plate. It was therefore necessary, first, to keep the gold melted; secondly, to adjust the time of the fall of the drop into it; thirdly, to ensure the opening at the right instant of the camera shutter; and, fourthly, to produce at the right fraction of a second the illuminating electric flash. The bullet was made of gold. Now for the resultant photographs. The first shows the bullet approaching the pool, the second the splash produced by the same bullet, about one hundredth of a second after contact with the molten gold. Those who are familiar with Professor Worthington's photographs of the splash of a drop, will perceive that the splash of the gold is practically identical with that produced in the less viscous liquid. That is what most of us would have expected.

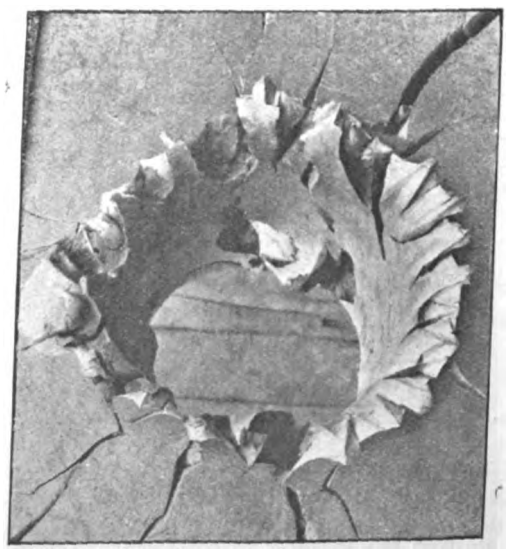
Let us proceed a step further.. What will be the result when a solid projectile of steel is urged against a solid armour plate of steel with a velocity of some sixteen hundred feet a second? The results

The Splash made by a Steel Shell on Armour Plate—Elevation.

may vary within wide circuits. The object of the maker of the projectile is to fracture or penetrate the armour plates, while on the other hand the maker of the plate hopes to shatter the projectile. If the former wins, and the plate is wholly or partially penetrated, a splash will often be the result, and allowing for the difference between the flaw of a solid, and the flaw of a liquid, the splash of the solid steel strangely resembles the splash of the fluid gold. That this is the case may be seen from the accompanying photographs of splashes of armour plates tested by the Government Ordinance factories. In these photographs a steel projectile,

Armour Plate partially penetrated by Shell—Plan.

weighing six pounds, was fired with a muzzle velocity of seventeen hundred and fifty-six feet per second against armour plate of rolled mild steel, three inches thick, and it produced in the $\frac{1}{3000}$th part of a second this beautiful splash of the steel plate which seems so solid. The importance of the point is this: When it is known that solid steel behaves like a viscous fluid, we are guided as to the steps which should be taken, with a view to its suitable treatment, so as to enable it to serve for defensive purposes. Its toughness or its



Armour Plate fractured by Steel Shell—Plan.

rigidity may be increased at will, either by varying its treatment, or by the introduction of suitable metals. If it were necessary to prevent a marble from entering milk, the surface of the fluid might be hardened by freezing it. An armour plate in the same way can have a face of rigid steel to break up a projectile, and a tough back which will save the plate from fracture.

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Astronomical Notes for March, 1903.

The Sun.

On the 21st (the Vernal Equinox) the Sun is said to enter the sign Aries, and Spring commences. He still continues devoid of spots of any magnitude. An annular solar eclipse occurs on the 28th, invisible at Greenwich, and only to be observed in China and Siberia.

Zodiacal Light.

This phenomenon may still be observed on moonless evenings, in the west after sunset.

The Moon.

The Moon will be in her first quarter on the 6th, become full on the 13th, and reach her last quarter on the 21st. New Moon will occur on the 29th. She will be in perigee on the 10th, and in apogee on the 22nd. She will be in conjunction with Venus on the 1st and 31st, with Mercury on the 27th, and Mars on the 15th.

No occultation of any conspicuous star or planet occurs, but the two following occultations of small fixed stars are interesting. On the 9th the star known as 51 Geminorum (magnitude 5·4) will be occulted, the disappearance taking place at 0 h. 23 m. a.m., the reappearance at 1 h. 1 m. a.m. On the 19th χ Ophiuchi (magnitude 5·0) will be occulted at 4 h. 1 m. a.m., and reappear at 5 h. 25 m. a.m. A near approach of λ Geminorum (magnitude 3·6) takes place on the 9th at 2 h. 27 m. a.m.

The Planets.

Venus, whose apparent diameter has now increased to 11″, sets more than 2 hours after the Sun at the end of the month, by which time, with her increasing northern declination, she will be a very conspicuous object in our evening skies in the north-west.

Mars is very well placed for observation during March, rising at about 7 o'clock in the evening in the middle of the month, his apparent diameter having nearly reached its maximum (14½″) for this apparition. This will occur a fortnight later, the planet coming into opposition to the Sun on the 29th, at 8 h. a.m. At this period Mars will be on the meridian (*i.e.*, due south) at midnight. On the 23rd he will be in close proximity to the fairly bright star γ Virginis, and there should be small difficulty in identifying this interesting planet.

Mercury, Jupiter, Saturn, and Uranus are all practically invisible for the purpose of general observation. Neptune comes to the meridian at 7 h. 26 m. p.m. on the 2nd, with a northern declination of 22° 20′, and a Right Ascension of 6 h. 4 m. 4 s., but as the tiny disc of this planet shows an apparent diameter of only 2″·6, it is only for those possessing the requisite optical power that it can in any way be said to be "favourably" situated.

The Constellation.

At the beginning of the month if we face due south at about 8 p.m., we shall note that Sirius is just to the west of the meridian, whilst Procyon, the largest star of the Lesser Dog, is at an almost equal distance to the east of that imaginary line in the sky. Higher up Gemini, with Castor and Pollux, will be observed exactly on the meridian. Elevating the vision still more, we shall reach the constellation Auriga, with Capella as its brightest star. The brilliant constellation Orion, with its conspicuous nebula and belt, and also containing an interesting occasional variable star in Betelgeuse, the "Alpha" of the group, will be found slightly to the west of the meridian, and above Canis Major.

On turning northward, we see the Great Bear in a more elevated position than last month, it being, indeed, not far from the zenith, but slightly to the eastward of that point. Due east we find the constellation Virgo (in which it will be remembered the planet Mars is situated) just rising, whilst further to the northward, Bootes, Corona Borealis, and Hercules have just risen above the horizon.

Horses in London.

In a recent paper on "Electric Automobiles," read before the Institution of Civil Engineers, Mr. H. F. Joel stated that, in London alone, there were over 16,000 licensed horse-carriages, apart from private vehicles, tradesmen's vans, &c., and it was estimated that over 200,000 horses were stabled each night in London, necessitating the daily removal of more than 5,000 tons of manure and refuse, in addition to what was distributed over the roads, and found its way into the residences of the people. The growth of London and other large cities made the problem of substituting motor-cars for horse-traction one of the first importance.

The Nile Sudd.

The photographs of the operations that have been conducted in cutting the Nile Sudd, which appeared in the February number of the *Illustrated Scientific News*, were lent by the Royal Geographical Society, and were reproduced from the Society's Journal. Our thanks are specially due to Dr. J. Scott Keltie for his kindness in lending them.

Notable Articles in Recent Periodicals.

Agricultural Education. *Agricultural Economist*, February.
Water-Tube Boilers—Niclausse. *Scientific American Supplement*, Jan. 24.
Diversity of Uses for Cold Storage. *Scientific American Supplement*, Jan. 24.
Barr and Stroud Electric Clocks. *Steamship*, February.
Pendulum Propeller Experiments. *Steamship*, February.
The Holy Shroud of Turin. Maj.-Gen. Waterhouse. *Nature*, Feb. 5.
Insects and Petal-less Flowers. G. W. Bulman. *Nature*, Feb. 5.
Jupiter's Markings. W. F. Denning. *Nature*, Feb. 5.
The Mexican Axolotl. Dr. H. Gadow. *Nature*, Feb. 5.
Steam Turbines. *Modern Machinery*, Feb. 1.
Chemistry of the Stars. A. Flower. *Knowledge*, Feb.
Path of the Moon. *Knowledge*, February.
Animal Windbags. *Knowledge*, February.
The Korting Two-Cycle Gas Engine. *Machinery Market*, Feb. 5.
Water-Tube Boilers. *Machinery Market*, Feb. 5.
Indian Physionomics. *Scientific American*, Jan. 24.
How a Telescope was Made. *Scientific American*, Jan. 24.
Californian Woodpeckers. *Scientific American*, Jan. 24.
Test of the New 16-in. Gun. *Scientific American*, Jan. 31.
The Annual Automobile Show. *Scientific American*, Jan. 31.
Radio-Activity of Ordinary Materials. Hon. R. Strutt. *Nature*, Feb. 19.
Oysters and Typhoid Fever. Prof. Hewlatt. *Nature*, Feb. 19.
The Cooper-Hewitt Lamp. *Scientific American*, Feb. 7.
Submarine Torpedo Boats. *Scientific American Supplement*, Feb. 7.
Torsion in Propeller Shafts. *Engineering*, Feb. 6.
Paris Automobile Exhibition. *Engineering*, Feb. 6.
The Port of London. *Society of Arts Journal*, Feb. 11.
Paper-Making. *Magazine of Commerce*, January.
The Physical Constitution of Jupiter. *Science*, Jan. 16.
Sir Oliver Lodge on "Electrons." *Journal of the Institute of Electrical Engineers*, February.
Spider Lines in Optical Instruments. "*La Nature*," Jan. 31.
Mr. Charles Bright on "Cables." *Nineteenth Century*, February.
The Aurora Borealis. *The Century*, February.
The Mechanism of the Air. *Contemporary*, February.

Weights and Measures.

An extremely varied, and even entertaining, discussion has been conducted at the Institution of Electrical Engineers, on the Metric System. The chief exponent of its advantages was Mr. Siemens.

Nearly everybody, certainly every educated person, is familiar with the arguments for the metric system. One might add that nearly every uneducated person is familiar with the chief argument on the other side—which is that numbers of people are satisfied with things as they are. But the discussion drew from Sir Frederick Bramwell some remarks which supplied to the advocates of things as they are such handy weapons with which to attack the metricians that every one ought to know them. Human nature, he remarked, would continue to use vulgar fractions, a half, a third, a quarter, and so on, and in a good many cases they were vastly more convenient. The decimal of one-quarter = 0·25 was bad, one-sixteenth = 0·625 was worse, a one-thirty-second = 0·03125 was worst. A sixty-fourth, a legitimate division, was terribly unwieldy, but these decimals were at any rate accurate, whereas, one-sixth, one-seventh, and one-ninth were both unwieldy and inaccurate, because, as in the case of one-seventh =0·142857 the user of them was confronted with a repeater. Again everybody could, without difficulty, square 3½, but who could mentally square 3·142857. Sir Frederick went gaily on to instance the difficulties which arose in remembering the right place in which to put the decimal point, and mentioned that in the newspaper reports of Sipido's attempted assassination of the King the length of the bullet was stated at 0·1 of a metre, a length of bullet which would have projected far beyond the barrel of the revolver. Finally, he quoted Rankine in support of his views—Rankine who felt so strongly on the point that he broke into poetry on the subject, and wrote the celebrated song, "The Three-Foot Rule," of which the concluding lines were:

"Oh, bless their eyes, if ever they tries
To put down the 'Three-foot Rule.'"

ANSWERS TO CORRESPONDENTS.

M. T. Wollond asks, with reference to our article on "The Skin of the Atmosphere," how these immense heights—viz., 36,000 ft.—can be verified. This is, of course, one of the great difficulties to contend with. If relying on barometric pressure, this, we know, is liable to vary by an inch or more on the surface of the earth, and in the upper air may vary more. It is this variation which we particularly wish to investigate. In the case of a small balloon at these great heights, invisible from the earth, it becomes practically impossible to determine the height attained, except by the barometer and other deductions. M. Cailletat has devised an apparatus consisting of a photographic camera, which automatically takes a photograph of the earth beneath at regular intervals. If these photographs depict some pieces of country which can be recognised, the height can be measured by the relative length distance between two known places. But at these immense altitudes it would not be often that a satisfactory photograph of the earth could be taken. With kites the matter is different, though, of course, the same great heights cannot be attained. The length of the retaining wire is known, its angle can be measured, and its catenary calculated, hence the vast height of the kite may be known. Moreover, the kite being held steady in the air, its height can, if not so great as to render it invisible, be measured by trigonometry.

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REVIEWS OF BOOKS.

"Comets and Their Tails," by Frederick G. Shaw. (Baillière, Tindall, and Cox.) 2s. 6d. The object of this little book is to bring forward a new theory, or what the author believes to be a new theory, of the composition of the tails of comets. It is that the phenomenon of a comet's tail is caused by the rays from the sun being altered by their passage through the *gaseous atmosphere* surrounding the nucleus of the comet, and thus rendered more vigorous and more capable of being reflected from the meteoric bodies, dust, &c., existing or moving through space, or from the sun's atmosphere, if such a matter exists, in the vicinity of the comet. It is not for us to give any opinion upon the likelihood of the correctness of this theory, but we can only say that it is put forward in a plausible way

From "Comets and Their Tails."

and should prove of interest to those who have made a study of this subject. We believe the author is not speaking in accordance with generally accepted modern theories when he states that "the corona of the comet possesses various chemical characteristics belonging and peculiar to itself, while the tail possesses only those peculiar to sunlight." We also think that he is incorrect in stating (though he does qualify it by adding "so far as I know") "the spectrum of the comet's tail proves that it only possesses the spectrum common to sunlight." But we will leave it to the reader to draw his own conclusions as to the statements made. The book is well illustrated with diagrams of Donati's comet, and is nicely got up.

"On the 'Beckman Rearrangement,'" by Julius Stieglitz. Preprint from the University of Chicago Decennial Publications, Vol. IX., 15 pp., 4to, paper; *net*, 25 cents.—"*On the 'Beckman Rearrangement,'*" by Julius Stieglitz. The various interpretations of this characteristic molecular rearrangement, including be one advanced by the author, are discussed critically in the light of experimental facts, especially of new ones established by the author's work with a number of collaborating students. The actual facts are found to agree best with the author's theory of the reaction.

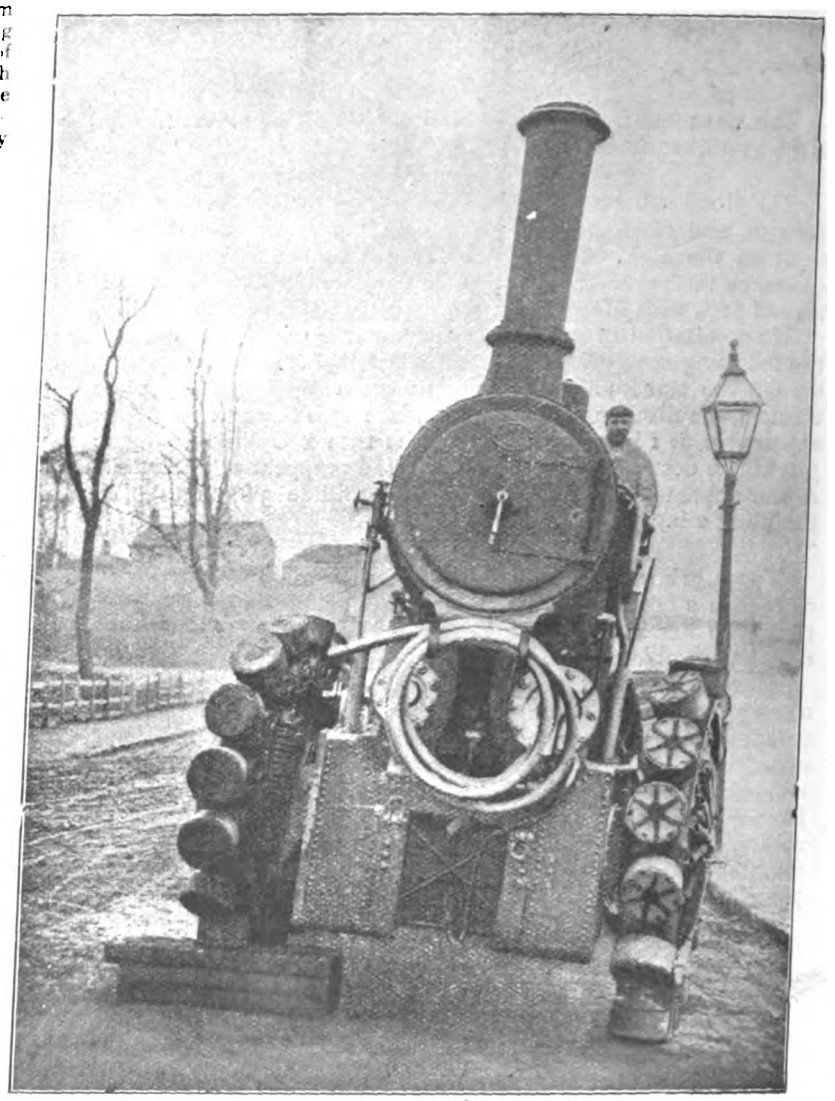
MR. R. S. CLAY, Principal of the Northern Polytechnic, Holloway, publishes with Messrs. Macmillan a book of **Practical Exercises in Light**, forming a laboratory course for schools of science. It is adapted to the requirements of students in the Advanced Stage for the South Kensington Examination in Light. The apparatus involved is kept to the simplest possible, and the work is furnished with numerous illustrations, and with additional exercises which enable students to test their knowledge.

"Real Things in Nature," by Mr. E. S. Holden, is a reading book of science prepared for American boys and girls, and published by the Macmillan Company. Its purpose is to explain the world in which the child finds itself, by a rough outline of facts in astronomy, physics, meteorology, chemistry, geology, zoology, botany, biology and ethnology, with familiar exemplifications of the principles and facts dealt with.

A NEW text book of **"Organic Chemistry,"** by Mr. J. B. Cohen, Lecturer in the Yorkshire College, now published by Messrs. Macmillan, is based on Mr. Cohen's experience in the lecture room, and makes a special object of maintaining a careful balance between the theoretic and practical sides of the subject.

A TREATISE on the **"Thermodynamics of Heat Engines,"** by Mr. Sidney A. Reeve, Professor of Steam Engineering at the Worcester (U.S.A.) Polytechnic Institute, is published by the Macmillan Company.

"A New System of Heavy Goods Transport on Common Roads," by Brameh Joseph Diplock. (Longmans, Green, & Co.) 6s. 6d. The author, having studied the subject of traction-engine haulage, in a practical manner, since 1885, may claim to be an expert in this matter. The system he advocates must then be considered with respect. In the first chapter he lays down seven axioms as to what the ideal system of road transport should fulfil. The inventor then traces the evolution of the "Pedrail," as he calls his completed machine. He points out that "the horse possesses a hauling power altogether out of proportion to its weight, and it is therefore evident that the more nearly a mechanical traction instrument assimilates in principle to the structure of the horse, the better will be the result." Further, he states that "the minimum of road-resistance would be obtained by rolling metal on metal, as in a railway," so the



Diplock's "New System of Heavy Goods Transport."

Pedrail is a combination of an endless railway with a trolling machine. Those who desire further information on this interesting novelty, which has proved itself to be most efficient in its trials, will find full details clearly described and illustrated in this book.

As an addition to the well-known Commercial Series of Messrs. Hooper and Graham, Mr. A. C. Poiré publishes with Messrs. Macmillan a work in French, "*Carnet de Notes d'un Voyageur en France*," designed as a reading book for students, and also as an introduction to the Geography of France from a business point of view. It contains a brief account of the industries, commerce, and agriculture of each province or important centre.

The new volume of the Macmillan Company's *Citizen's Library* is a treatise on *Irrigation Institutions*, by Mr. Elwood Mead. It is a discussion of the economic and legal questions created by the growth of irrigator agriculture in the Western States of America, and may be specially commended to advocates of scientific agricultural development in South Africa.

THE following books are in preparation at the Clarendon Press:—

"*The Theory of Continuous Groups*," by J. E. Campbell, M.A.

"*An Experimental Course of Geometry*," by A. T. Warren, M.A.

"*Mathematical Crystallography*," by H. Hilton, M.A.

Schimper's "*Geography of Plants*," English edition, with many illustrations, by Percy Groom, M.A., and W. R. Fisher, B.A.

Goebel's "*Organography of Plants*," authorised English edition, by I. Bayley Balfour, M.A., F.R.S. Part II.

Pfeffer's "*Physiology of Plants*," Vol. 2, translated by A. J. Ewart, D.Sc.

"*Protoplasmic Streaming in Plants*," by A. J. Ewart, D.Sc.

Exploration in Greenland.

QUITE recently the Danish Commission for Geological and Geographical Explorations in Greenland celebrated its twenty-five years' existence, during which period science in more than one way has been enriched, and our knowledge of arctic regions has been added to owing to the exacting and painstaking survey of Greenland. During these years 38 expeditions have been fitted out in Denmark and sent up, the best-known ones being the Holm expedition to the East Coast of Greenland, where discovery was made of an Esquimaux tribe at Angmasalik, and the recent one under command of Lieutenant Amdrup, of the Danish Navy, when the whole eastern coast-line was mapped in its entirety. The results of the various works carried out are published in "Information on Greenland," a monumental series of at present twenty-seven volumes, partly written in French.

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Recent Patents.

19,515. Telephone Indicators. THOMPSON, E., 15, Loudon Street, Calcutta, India. Oct. 1.

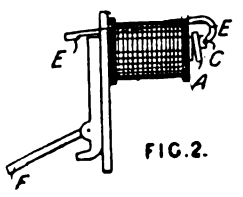
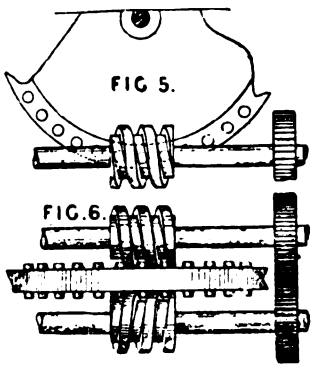


FIG.2.

The armature A, carrying the hook E which holds up the shutter F, is supported on two pins C projecting from the top of the magnet cores. The faces of the cores may be inclined, or the armature may hang out of the perpendicular, so that it may fall away when the circuit is broken.



20,486. Worm Gearing. BUTLER, J. B., Summerhill House, Saint George, Bristol. Oct. 14. *Patent not yet due for Sealing.*

The teeth of wheels and racks driven by worms, screws, &c. are made in the form of round pins arranged to turn about their axis upon ball or other bearings. Figs. 5 and 6 show a pair of worms gearing with double-ended pins projecting on each side of a wheel. The same arrangement may be used for a rack. The pins may project radially.

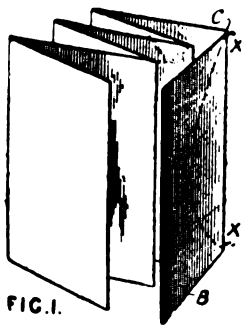


FIG.1.

20,634. Newspapers. PATTISON, W. E., 300, South Main Street, Sharon, Massachusetts, U.S.A. Oct. 15.

Newspapers are printed on a single sheet and folded in zig-zag fashion, the last fold *c* forming either a covering leaf B or, as shown in dotted lines, a flap X.

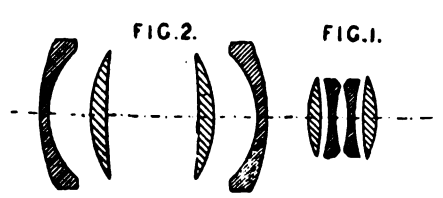
20,747. Incandescent Gas, &c., Lamps. BOULT, A. J., 111, Hatton Garden, London.—(*Plaissetty, A. M.; Paris.*) Oct. 16.

The fragility, the tendency to shrink, and the progressive loss of light-emitting power of mantles are obviated by the use of a mantle which, before burning, is composed of cellulose in the condition of artificial silk and of hydrated oxides of the illuminating metals, the inorganic matter bearing a much larger proportion than usual to the organic matter. Gelatinous hydrated oxides of the illuminating metals, obtained by precipitating their salts with ammonia or other alkali, are mixed and kneaded with Schweitzer's ammonium copper or other watery and non-spirituous solution of cellulose. The resulting homogeneous fluid is spun into threads by being forced out of capillary tubes into a neutral or alkaline coagulating-liquid, the thread as usual being composed of several fibres twisted together. Before spinning, the solution should be strained through wire gauze, the interstices of which are smaller than the bore of the capillary tubes. Any remaining copper is removed by washing in solution of ammonia, and finally in pure water, and the thread formed is washed, dried, and knitted or woven into mantles. In a modification, non-nitrous cellulose in the condition of artificial silk is soaked in a concentrated solution of salts of the illuminating-metals until the solution of salts has completely permeated the fibre. The fibre is then dried and passed into a strong solution of ammonia or other alkali to decompose the salt throughout the structure of the fibre and produce hydrated oxide.

20,755. Explosives. FUHRER, J., 5, Marokkaner Gasse, Vienna. Oct. 16.

Relates to a safety detonating composition to be employed as a substitute for fulminate of mercury, and consists of a mixture of cupr-ammonium nitrate, potassium nitrate, and aluminium, alone or mixed with an ammonium-nitrate explosive.

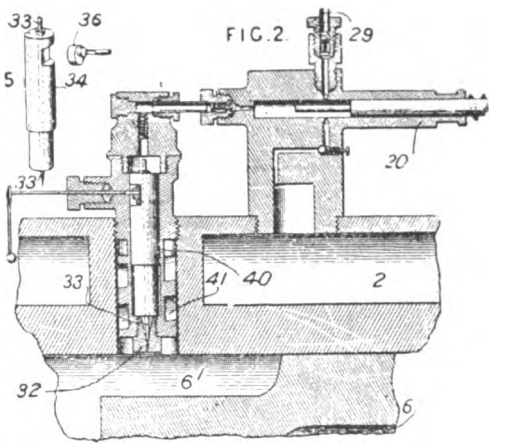
21,211. Photography. STEINHEIL, R., 7, Theresienhohe, Munich, Germany. Oct. 22. *Grant of Patent opposed.*



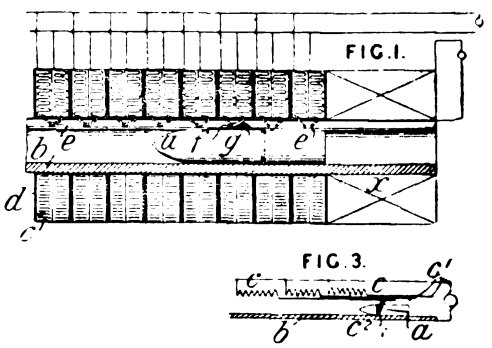
Lenses.—Relates to a photographic or like objective lens which is corrected for spherical, chromatic, and astigmatic aberration without using a normal and abnormal pair of glasses. The Petzval equation $\Sigma \frac{1}{nf} = 0$ is complied with by suitably determining the distances of the lenses. The combination produces a lens of positive focal length. Fig. 1 is an example of a lens with crown-glass lenses outside, and Fig. 2 of a lens with flint lenses outside.

20,892. Explosion Engines. THOMPSON, W. P., 6, Lord Street, Liverpool. (*Colborn, E. F.; Pepperton Place, Salt Lake City, Utah, U.S.A.*) Oct. 18.

A mixture of oil and water is forced through the valve 33 into the charge of compressed air contained in the cylinder, and becomes vaporized in its passage. The explosion forces some of the combustible through helical passages 41 into a recess 40, from which it gradually escapes and burns during the admission of the new charge of air to the cylinder, and thus heats the nozzle 32. The air charge is compressed in the crank chamber, and is admitted to the cylinder by a port uncovered by the piston just before the exhaust port is uncovered; a recess 6^1 in the piston 6 directs the air past the nozzle 32. The oil and water are supplied by a pump 20 operated by a tappet, the water being drawn from the cylinder jacket 2 and oil from the pipe 29. The valve 33 is carried in a grooved sleeve 34, which is adjusted in height by a cam 36. Crude and heavy oils may be used in the apparatus.



20,935. Ordnance. WISE, W. L., 46, Lincoln's Inn Fields, London.—(*Birkeland, K.; University of Christiana, Christiana.*) Oct. 18.



Electromagnetic. — The projectile is propelled by electromagnetism produced by means of a solenoidal winding containing the bore of the gun. The gun tube *b*, Fig. 1, is slotted throughout its length and surrounded by solenoids *c*. The solenoids are connected in series in pairs, and each group of two solenoids is arranged on a reel *d* threaded on the tube *b*. The contact-arms *e* of the solenoids extend into the slot in the gun tube, and are successively separated by the nose *f* of the slide *g* as it is pushed forward by the projectile *a* during its passage down the gun. A special solenoidal winding *x* saturates the projectile with magnetism before it begins its journey. In the modification shown in Fig. 3, the solenoids *c* are connected together in groups which are connected to the main in parallel, the members of each group being placed in series. The groups are so energized that the projectile will be under the influence of a compound solenoid composed of a number of consecutive solenoids and located at the most suitable distance in front of the projectile *a*. The rear end of each group of solenoids is attached to a rod c^1 leading rearwards, and arranged to be rubbed by a contact piece c^2 carried by the projectile. The other apparatus employed is described and claimed in Specification No. 14,440, A.D. 1902.

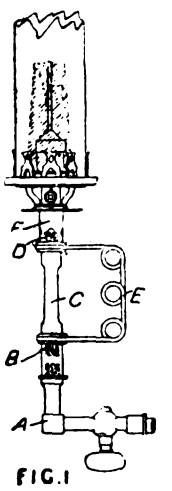
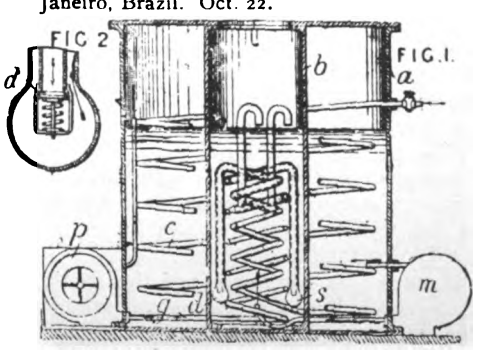


FIG.1

21,116. Incandescent Gas Burners. MARSHALL, C 100, Gertrude Street, Fitzroy, Victoria, Australia. Oct. 21.

The transmission of shocks and vibrations to the fragile mantles is prevented by connecting the burner F to the bracket or other gas fitting A by an anti-vibration device comprising two screw collars B, D for attachment to the respective parts A, F, a resilient connection formed by bending a steel or copper wire E somewhat as shown in Fig. 1, and an indiarubber or other flexible connecting gas-supply tube C.

21,191. Liquefying Air, &c. HESS, E. J., 29, Rua 7 de Setembrea, Rio de Janeiro, Brazil. Oct. 22.



The apparatus produces liquefied air and motive power. A closed vessel *a* surrounds an open one *b*, both containing liquefied air, and atmospheric air is plunged through a coil *c* in the vessel *a* and gasefies some of the liquid therein. This gas works a turbine or other motor *p*, and the exhaust, which has become further cooled by expansion, passes to a coiled pipe *g* in the vessel *b*, and condenses and is forced through the valve *s* into the chamber *b*. Similarly, the air that condenses in the pipe *c* is forced through a valve *d* into the chamber *b*. The liquid in the chamber *b* is withdrawn by a pump *m*, to replenish the supply in the vessel *a*. The pumps are operated by the motor *p*.

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Sounding the Upper Air.

THE results of the ascents arranged by the International Commission for 4th December last with balloons and kites have just been published as follows :—

Jtteville.—Register balloon sent up 8 h. 45 m. Temperature on ground, 4°8. Greatest height, 14,828 m. Lowest Temperature, 52°9.

Chelais-Meudon.—Register balloon sent up and lost.

Strassburg.—(1) Balloon ascended 9 h. 8 m. Greatest height, 16,500 m.—65°2. (2) at 9 h. 19 m. Temperature on ground—7·8. Greatest height, 3120 m.—17°.

Berlin.—Kite sent up (1) 10 h. 33 m. till 12 h. 40 m. Temperature below, 11°; at 470 m., 15°1. Greatest height, 649 m.—10°5. (2) at 4 h. 6 m.—4 h. 50 m. Temperature below, 9°4; at 518 m., 12°.

Balloon at 7 h. 20 m., a.m. Temperature below—11°5. Greatest height, 14,465 m.—35°. Lowest temperature, 46°7 at 9670 m.

Manned balloon ascended 10 h. 30 m.; landed 3 p.m. at Dittfurt. Temperature, 13°2. Greatest height, 950 m. Lowest temperature, 16°2.

Vienna.—(1) Manned balloon ascended 7 h. 28 m., a.m.; landed, 11 h. 10 m. at Sommerain. Temperature, 6°6. Greatest height, 4,200 m.—21°4. (2) Register balloon at 7 h. 45 m., a.m.; results not known. Landed near Mocsansk.

Rome.—Manned balloon at 7 h. 38 m.; landed, 9 h. 45 m. near Fiumicino. Temperature, 6°8. Greatest height, 2,760 m. Lowest temperature, 8°1.

Pawlowsk, near St. Petersburg.—Balloon ascended 10 h. 25 m.; landed near Ssala. Temperature, 20 7. Greatest height, 17,700 m. Lowest temperature, 63 5 at 11,220 m.

Blue Hill Observatory. (U.S.A.)—Kites attained 1,100 m.

The next date fixed upon for a series of ascents is Thursday, March 5th, when it is to be hoped some data will be obtained of the upper air over Great Britain.

Prize Competition

ONE of the principal objects of this journal being to encourage and foster the introduction and propagation of new ideas, the proprietors have decided to offer a series of money prizes to those who, in their opinion, send in the best and most practical solution of certain problems which will be set each month.

The designs must be sent in within a fortnight of the publication of the problem, *accompanied by the coupon* cut from this paper. Marks will then be allotted by the judges, and the competitor gaining the greatest amount of marks each month will be awarded the monthly prize of ONE GUINEA. But in order to encourage clever inventors, and not merely reward those who may happen to hit upon a happy idea, a GRAND PRIZE OF **ONE HUNDRED POUNDS** will be awarded at the end of the year (*i.e.* after 12 problems have been set) to that inventor who shall have gained the greatest aggregate of marks during that period, provided he shall have gained at least *30 per cent. of the full marks* in at least six of the competitions (whether he has gained a monthly prize or not).

In the event of an equality of votes or other exceptional circumstances, the proprietor will decide on the fairest method of distribution.

The following rules must be strictly adhered to, and solutions sent in not in compliance with them will be disqualified.

1. The solutions sent in must be concise, yet fully descriptive of the idea intended. To comply with this they must not exceed 300 words, and not more than two simple diagrams should accompany it.
2. Solutions will be published as considered desirable by the editor.
3. Competitors may obtain patent rights for their ideas, but they must run all risk of the publication in this paper interfering with the obtaining of such rights.
4. The number of marks awarded to each solution will be published every month. Competitors may send in their designs under a fancy name for publication, but their true names and addresses must be inserted on the coupon, which, in the event of their winning a prize, will be published.
5. The same person may send in two or more solutions so long as a separate coupon accompanies each. All marks so gained will count for the grand prize, but the monthly prize will only be awarded for the one best solution.
6. Novelty of design is not a *sina qua non* (since this would be extremely difficult to prove), but only the person sending a description with the coupon is entitled to reward.
7. It would add to the value if a statement be added to say if the design has been practically tried; but to corroborate this the inventor may be called upon to give a demonstration before receiving a prize.

Results of last month's Competition.

SECOND WEST (**60**). A square tube, 6 ft. 4 ins. long, usually held vertically, has prism fixed in each end. Lower prism actuated by levers and screw. Telescope opposite movable prism. Thus the angle subtended by the distant object at each end of the fixed base is determinable. *(Quite a good solution, if not very original.)*

GUNNER (**50**) recommends Forbes's stereoscopic range finder, and describes it. *(Though, of course, a good form of instrument, no originality is displayed in this solution, and it is original invention that we wish to encourage.)*

R. FENTON (**55**). A cord (wire) is formed into a rectangle, with rings at each corner and diagonals. The sides at 30 yards long, the ends 3 yards. This is pegged on the ground, or held stretched by four men. One end is aligned on the distant object. On viewing the object from the corner at the other end, it will be seen over the cord on the far side, which is marked off in a scale of yards. *(This would certainly form a very simple, easily worked, and portable instrument, but whether in practice it would be sufficiently accurate is doubtful.)*

MEPHISTO (**54**). An improvement on the Barr-Stroud, consisting of tube with reflectors at each end, pivoted at centre.

KHARKI (**50**). Two telescopes fixed apart by rods, one of them pivoted in centre and moved by screws.

K. O. H. (**45**). Vertical staff rising above telescope, with mirror at top, reflecting image of distant object into dark box above telescope. Angle of mirror adjustable, and read off on scale. *(Large and cumbrous apparatus.)*

H. P. LEGGE (**40**). Rectangle with one arm hinged, and moved by micrometer screw over dial. *(No dimensions are given, but it is said that "accuracy will increase with its size." It would have to be at least 6 ft. long, and therefore very large.)*

E. M. F. No. 1 (**46**). The instrument consists of a ruler 2 ft. long, from one end of which projects an arm of ½ inch. A reflector is attached to get the right-angle. A 100 yard base is taken at right angles to the range. When at the far end of the base, on fixing the instrument at right angles to the base, the distant object viewed from the end of the projection comes over one of the divisions on the ruler. *(Simple apparatus, but probably not very accurate.)*

E. M. F. No. 2 (**45**). Two triangles with pins at each corner are mounted on tripods. One observer aligns his triangle on the distant point, and then selects base at right-angles. The other observer sets up his instrument at other end of base, which is measured with tape. The third pin on this instrument is on a movable arm, by which the range may be read.

L. R. CONNOR (**55**). Two telescopes fixed parallel about six ft. apart, have cross wires at each end. One is sighted on the object, the other contains a vertical movable wire which is then aligned on the object with a micrometer screw. *(A practical device, but rather large and clumsy apparatus.)*

KASS (**50**).—Binoculars with reflectors arranged so that the views as seen by each eye are reflected from ends of base about four ft. long. *(Same general idea as Forbes rangefinder.)*

HUMBER (**25**). Two tubes arranged to be looked through like field glasses, but the angle of their axes can be altered to suit range. *(Base practically too short for anything over 100 yards or so.)*

HARDSTAFF (**25**). Telescope with long focus. Image examined by very sensitive eye piece adjusted by micrometer screw, and range thus taken by focussing. *(Simple, if possible, but very doubtful if such an instrument could be practically made.)*

R. J. M. (**15**). Wooden sector marked in degrees enables right-angle to be measured at one end of base, 50 yards or so long. At other end, sector is used to measure angle subtended.

KASS No. 2 (**34**). Instrument for use at sea, to measure the vertical distance between the horizon and the water line of a ship, whose range is required. *(Limited use. Depends on being able to see horizon and waterline of ship, also on height of observer above water.)*

The Monthly Prize of One Guinea has therefore been awarded and sent to "Second West"—

MAJOR L. S. BLACKDEN,
Cothill, Tonbridge.

We much regret that two misprints occurred in the last number regarding the awarding of marks.
Second West No. 2 gained 67, *not* 87 marks. X. Z. gained 15 marks.

The subject for next month will be—

AN AUTOMATIC FIRE ALARM,

Electrical or otherwise.

Coupons to be delivered at this Office by first post on Monday, March 16th.

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Scientific News.

A Monthly Journal devoted to Popuiar Science.

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Silica-Glass.

BY W. A. SHENSTONE, F.R.S.

WE all know the valuable qualities of glass. Not only is it transparent, hard, and indifferent, or nearly indifferent, to most liquids, including some of the strongest acids, but some varieties bear very high temperatures without softening, and yet every variety, if sufficiently heated, can be made as plastic as wax, and in that state can be fashioned, like clay in the hands of the potter, into apparatus exhibiting almost every form that science demands.

So important to us is glass that the complete destruction of his laboratory by an earthquake would hardly disturb a chemist or physicist more than the discovery one fine morning that in future he must work without it. Nor would the chemists and physicists alone be upset by such a catastrophe. Imagine the face of a biologist suddenly deprived of his microscope, or the dismay of an astronomer robbed of his telescope. Would not these observers minus their special instruments be as helpless as a chemist or a physicist without flasks, test-tubes, thermometers, barometers, and all the rest of his multiform stock of glass instruments?

And yet, though he cannot do without it, glass is, to the experimenter, a constant source of irritation and worry. Does he desire to examine the ultraviolet rays of the spectrum? Alas! glass is quite opaque to such rays. Does he need some material which is really unaffected by solvents? If so, glass is of little use to him. Even water cannot stand in a glass vessel for an hour and retain its original purity. Whilst the tendency of glass to crack under the influence of changes of temperature, the fact that it is by no means perfectly elastic even when cold, nay, even its greatest virtue of becoming plastic when heated are all in their turn sources of difficulty and disappointment.

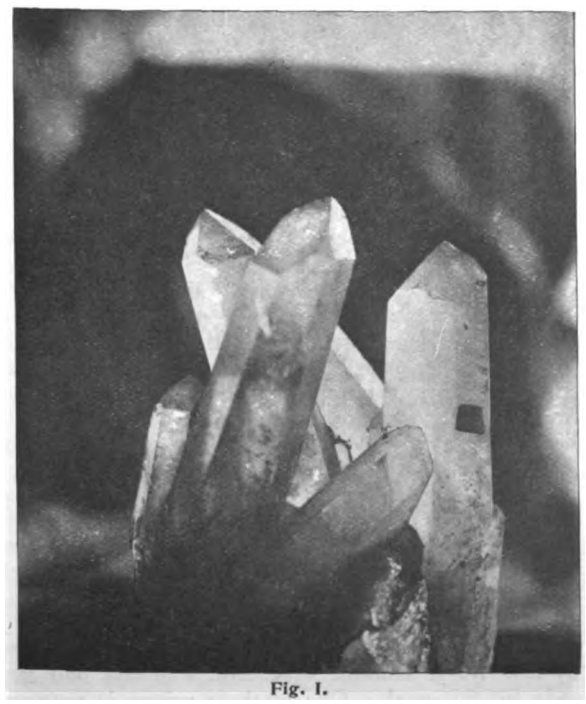

Fig. I.

Of course, we have many substitutes that can be used in place of glass for special purposes, such as earthenware, porcelain, nickel, and platinum, but none of these and not all of them together really combine all the qualities we seek in a glass; and thus it has come about that of late years a small band of experimenters have sought to press quartz or rock crystal, which can take on a vitrified or glass-like form, and is more infusible, more insoluble, more truly and completely transparent, more elastic and far more indifferent to changes of

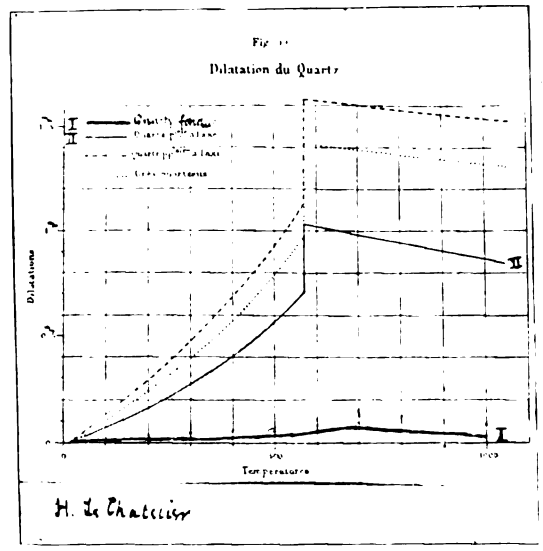

Fig. II.

temperature than any known glass, into the service of science, and so of mankind. Nor have these attempts been altogether without success. As long ago as 1839, M. Gaudin spun threads and made pellets of silica, and thirty years after, 1869, M. A. Gautier actually made tiny tubes and bulbs of silica, which he exhibited at the Paris Exhibition in 1878. Whilst a few years later, 1889, Prof. C. V. Boys not only produced fine tubes and bulbs of silica-glass, but by his beautiful applications of "Quartz fibres" in physical experiments, made us really realize for the first time the valuable properties of this useful and remarkable substance; with the result that gradually larger and larger vessels have been constructed, and that apparatus of silica-glass has now become part of the equipment of science, and is playing its part in promoting the progress of research in other fields, besides those into which Prof. Boys first introduced it.

Silica-glass differs from ordinary glass, chemically, in the greater simplicity of its composition. The latter, as we all know, is a mixture of two or more compounds of silica with basic substances such as oxide of lead, or oxide of sodium. The former is simply silica, *i.e.*, oxide of silicon converted into a glass by the action of heat; the raw material being quartz or rock crystal, a substance often met with in small hexagonal prisms with pyramidal ends and known popularly as Cornish or Bristol diamonds, and also occasionally in larger masses (Fig. 1).

Some magnificent specimens have been met with in the Alps, and the illustration given below will give some idea of the character of these crystalline masses of quartz.

Our chief source of supply for silica is Brazil, where it occurs in irregular masses in river beds. I may add that some beautiful specimens from Uganda were shown at the Royal Society about a year ago by Sir Harry Johnston, but I am not able to say if any considerable quantity is likely to be derived from this source.

Quartz itself is a beautiful and highly-transparent substance, and it is used a good deal for lenses of various descriptions, but the reader must not suppose that quartz or rock crystal in its natural state is a glass. On the contrary, quartz consists of crystals or fragments of crystals, which by no means exhibit exactly corresponding properties to those of silica-glass, though it has qualities of its own which are exceedingly valuable. The former, for example, when suddenly heated, falls into many pieces, whilst tubes and even moderately thick rods of the latter may be alternately heated to whiteness and then plunged into liquid air with impunity. The former exhibits definite crystalline forms, whilst the latter, like glass, is not crystalline. Quartz, again, rotates polarized light, whilst vitrified silica is quite inactive. On the other hand, silica-glass, like quartz, is transparent, as we shall see, to the ultra-violet rays, insoluble in many solvents, and a good insulator. But quartz, when heated, be-

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comes as plastic as glass at about the melting point of platinum, and then may be manipulated in the oxy-gas flame as easily as glass is in the flame of an ordinary glass-worker's blowpipe; though not, of course, so quickly, so inexpensively, nor, at present, in such large masses. Moreover the plastic silica after cooling is no longer crystalline, but is found to be transformed into the silica-glass, which is the subject of this article.

This silica-glass is harder than felspar, but not so hard as chalcedony. It can be cut with a diamond or with a good file, and then breaks with as clean a fracture as glass itself. Its melting point is not definitely known. It remains solid, as stated below, at about

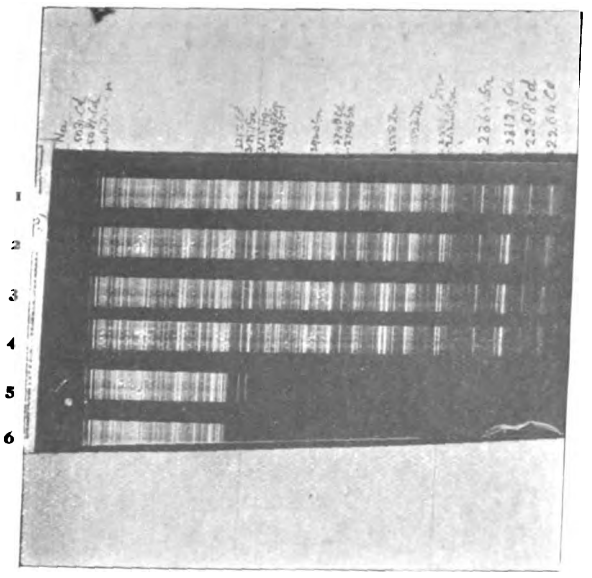
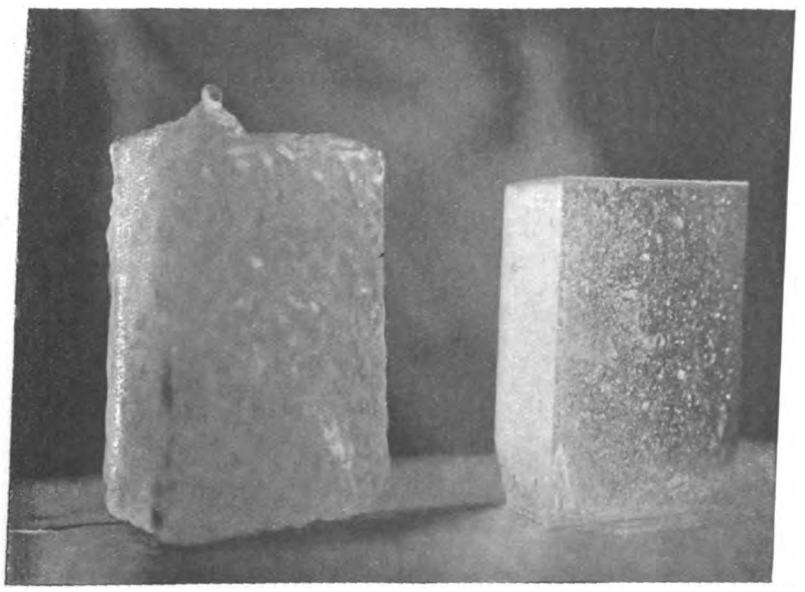


Fig. III.

1,500° C., and it is certainly less fusible than platinum, but it becomes plastic at temperatures approximating to the melting point of that metal.

One of the most valuable characters of silica-glass is its very small co-efficient of expansion. Prof. H. Le Chatelier has compared its behaviour in this respect with that of other varieties of silica, and his results are graphically represented on the following table of curves, for which I am indebted to his kind assistance.

I believe, however, that the curve for "Quartz-fondú" rather understates the case: for while the figures obtained by Le Chatelier give the mean co-efficient of expansion of silica-glass between 0°C. and 1,000°C. as 0.0000007, Professor Callendar finds that the co-efficient of expansion of a rod of very pure material prepared by me to be no



4b. Fig. IV. 4a.

more than 0.00000059, which is only 1-17th as great as that of platinum, and far smaller, I believe, than that of any similar substance yet studied. Up to 1,000°C. silica-glass not only expands regularly, but returns very accurately to its original volume on cooling. It is, therefore, likely to be very valuable in thermometry. A thermometer made of silica-glass and containing a given mass of mercury in the bulb would have somewhat longer degrees than a similar thermometer made of glass, and Professor Callendar's observations confirm the idea that, owing to the elasticity of silica-glass, the zero point of such a thermometer would probably be liable to much smaller variations than a glass one, which would be a very considerable advantage.

Silica-glass, however, is not any more free from the defects of its qualities than other materials, and its small expansibility, so valuable for many purposes, makes it difficult to seal electrodes into vacuum tubes made of silica; a circumstance which is all the more regrettable since Professor Trowbridge has shown lately that we may expect to obtain new and very important results, both from the point of view of physics and astronomy, by studying the spectra of gases confined in silica-glass tubes, owing to the very powerful discharges that can be employed without melting up the tubes. Hydrogen, for example, when examined with such discharges as may be used in silica tubes, gives altogether novel results. Its spectrum no longer consists to the eye of a few bright lines, but seems continuous, though a more exact study reveals the presence of both bright and dark lines in the ultra-violet portion, the dark lines in question never having been seen before. Professor Trowbridge describes the light that can be obtained in these tubes as the most intense that has yet been studied.

Although a rod of silica, heated to 1,000°C., returns to its original length on cooling, Professor Callendar finds that it is not quite so elastic, and, in fact, undergoes slight permanent elongations at tempera-

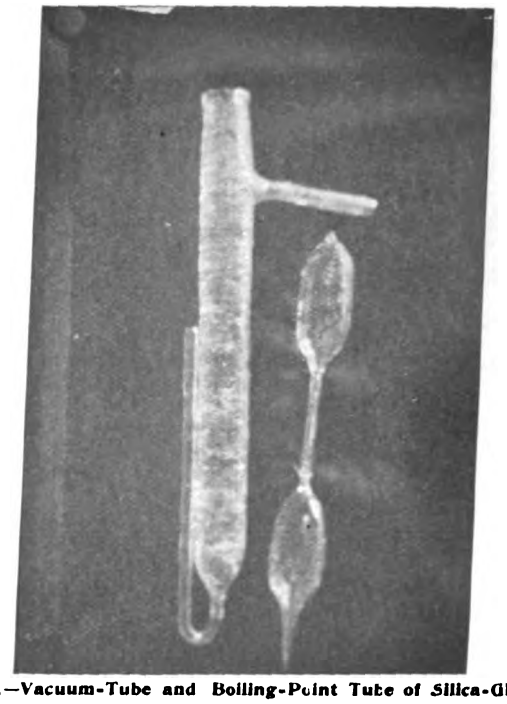


Fig. V.—Vacuum-Tube and Boiling-Point Tube of Silica-Glass.

tures above this. Its rate of expansion, moreover, falls off rapidly above 1,000°C. and becomes a contraction at about 1,200°C. The reader will see from curve 1 Fig. II. that Le Chatelier made a somewhat similar observation.

The rod examined by Professor Callendar, which was very pure, showed that silica remained solid up to 1,500° C., a fact which will make silica-glass tubes very useful for the jackets of platinum-resist-

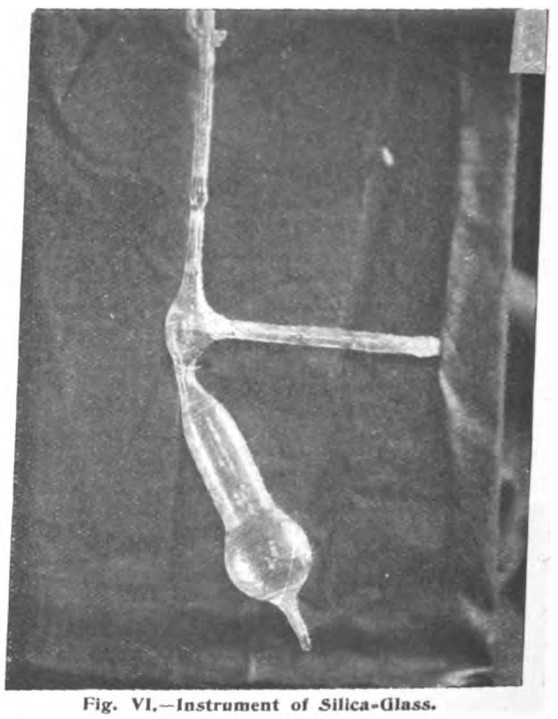


Fig. VI.—Instrument of Silica-Glass.

ance thermometers, by increasing the range of temperature over which they can be employed, and generally whenever a very infusible and transparent solid is required. Indeed, M. Dufour, of Paris, has already taken advantage of these very properties by constructing thermometers in which mercury is replaced by tin or other metals, and which, of course, can be used for measuring temperatures at which a mercury thermometer would be useless, owing to the comparatively low boiling point of that metal.

Another property of silica-glass of very great importance is its transparency to the ultraviolet rays. Ordinary glass will not transmit these rays. Silica-glass transmits them as well as quartz or air itself, as will be seen from the following photograph taken to test the point by Dr. A. Wynter-Blyth. Number 1 shows the transparency of air, 2 and 3 that of quartz, 4 that of a plate of pure silica-glass, and 5 and 6 give the very inferior results obtained when plates of soda-glass and flint-glass were used.

The optical properties of silica-glass are now being most thoroughly studied by Mr. W. J. Giffard, of Chard, who has had large silica prisms made for this work. One of these prisms is represented full

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size, and also a lump of the glass uncut in figures 4a and 4b. The subject is very important, as there is a distinct field of usefulness for such a material as silica-glass in connection with the construction of lenses for microscopes.

Another department of work in which silica-glass seems destined to be valuable, to mention only one more out of many, is the study of the chemical and physical properties of pure gases. It is very difficult to get trustworthy results when the gases are confined in vessels of glass, and, in fact, research in this subject cannot be pushed to the furthest point when vessels of any basic glass yet known to us are used. To obtain a pure gas one must confine it in a vessel which is absolutely clean. Now the most brilliant glass surface is by no means clean in the chemical sense. It bears upon it a layer of matter condensed from the air which can only be removed by heating it to such temperatures as cannot be safely applied, even to the best products of the Jena factories. Silica tubes can, however, be made much hotter without softening them, and hence we can get cleaner tubes and secure our gases in a greater state of purity within them.

It must not be supposed that silica-glass has no defects. I have already mentioned one source of difficulty. Another is that it is permeable to hydrogen, like platinum, though in less degree, at about 1,000°C. Again it is destroyed as rapidly when it is heated with basic substances, such as lime or copper oxide, as platinum is by chlorine. Even dust containing such substances very seriously damages a thin hot silica rod.

What I have said about the high melting point of silica may very well have conveyed the idea that the new glass must be much more difficult to manipulate in the flame than common glass. But this is by no means the case. Within certain limits silica is more easy than glass to work with, not more difficult. It is, however, much more expensive, as one must use an oxyhydrogen or an oxy-gas flame, and some of the earlier stages of the process take rather a long time to carry out, which, of course, adds to the cost. In one respect silica-glass is not only easier to work than ordinary glass, but very much easier. An inexpert workman can make complicated joints in silica, which would be quite beyond his power if he were using ordinary glass. The reason for this is quite simple. All forms of ordinary glass resent more or less strongly, being subjected to frequent changes of temperature when being worked before the blowpipe, and, again, all joints, and especially those that are at all complicated, must be kept at a tolerably uniform temperature throughout till they are complete, and they must be cooled regularly and gradually afterwards. Now, I do not know what might happen to a very massive lump of silica—I have known very large masses to exhibit cracks as the result of unequal heating—but in the case of tubes of moderate size and thickness, it would, I believe, be quite safe to drop cold water on a joint at any stage of the process of making it. Certainly none of the above precautions need be taken when working with silica-glass, and if a joint should grow lumpy, or if you should blow holes in it, or if it should come to grief in any other way, there is no need to sacrifice the work. It can be put aside at any stage and in any state when you are beaten for the time, and then be plunged again into the flame and finished at some future opportunity without any risk of its falling to pieces. Now, in my experience, the most skilful glass-worker would be unable to treat his work in this free and easy way if he were fashioning an instrument in any other kind of glass. This fact enables a beginner at silica-working to pick up the process much more rapidly than one does the corresponding art of glass-blowing. But making a long silica tube is rather a tedious affair, and those who can afford it will probably find it best to purchase tubes and fashion them into apparatus as one does in the case of glass tubes. For this work the best kind of burner is the mixed gas burner, the best I have met with being the injector burner of Mr. Jackson, of Manchester. There is a particular spot in the oxy-gas flame which is hotter than any other part, and it is in this that silica-glass must be heated. It is a little difficult to hit upon this point at first, but when one has learned to do this, all difficulties vanish.

The eyes of all who work silica in the flame must be protected with *very dark glasses*, and these must be changed when they become hot. They should be so dark that white-hot silica does not look very bright when seen through them. If every precaution be not taken to protect the eyes thoroughly, really serious trouble may result.

Figures 5 and 6 of apparatus made by Mr. Lacell when we were working together on this subject will show the kind of apparatus that may be turned out from silica tubes after a little practice by anyone who is handy with his fingers. There is one precaution I ought not to omit to mention. As a very small proportion of impurity will spoil silica-glass, one must work in a place as free from dust as may be, and avoid touching the material with the fingers as much as possible whilst it is being fashioned.

W. A. SHENSTONE.

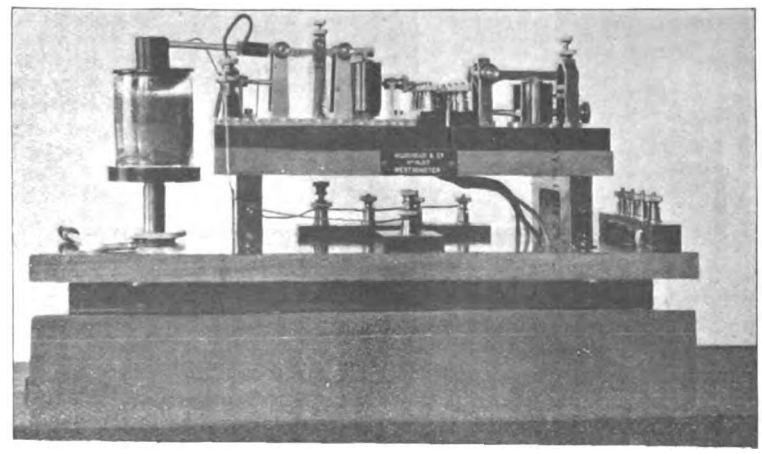
Clifton College, March, 1903.

Wireless Telegraphy.

The Lodge-Muirhead System.

By E. S. Grew.

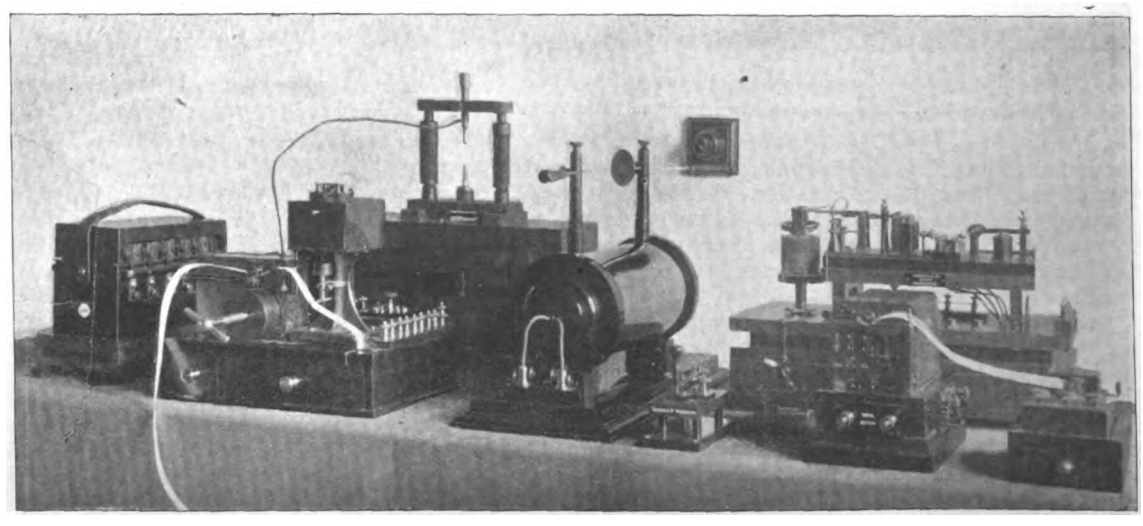
In considering systems of wireless telegraphy it is useful to regard the principles and analogies of the mechanism by which the electric waves are sent out into space. A very useful analogy has been suggested in the fog siren which sends out sound waves, and which is fitted with a pump, a reservoir, and a revolving disc. Through the holes of the disc the air from the reservoir rushes and makes air waves. In the same way in wireless telegraphy we have an induction coil which is the pump for forcing electricity into our apparatus; a reservoir in the form of a Leyden jar which will emit the electricity as it overflows; and a sparking coil that takes the place of the, pierced revolving wheel and lets the electricity out in spurts, or jets



The Lodge-Muirhead System—The Buzzer.

or sparks. Now what happens as the electric sparks or jets rush out. We may imagine the ærial rod from which they are discharged to be full of those electrical twists in the ether which Sir Oliver Lodge has recently described in his papers on "Electrons." When the rod is over-charged with these electrons they rush out across the spark gap made by the two dissevered spheres in the rod's length; and we can imagine them spurting out as a jet of water spurts out from a hole in a fire hose. But just as the spurting jet of water if it fell into a pool would produce ripples on the surface of the pool at right angles to the plane of its own direction, so we can imagine the jet of electrons as they curve through the ether setting up great electric ripples in horizontal planes. Those electric ripples spread and spread—setting up a train of waves—until they reach the distant object which we call the coherer. Now we know that a magnet gives rise to a field of force. In this instance the case is reversed. A field of force, transmitted from our electric fog siren, invades the coherer or receiver and produces certain electro-motive changes in it and about it. These are recorded by it and the electrical signal transmitted is recorded and completed.

Let us return to our pump and reservoir. In making signals in a lecture room with an induction coil, or even over distances of a few miles, one could use a Ruhmkorff 10-inch sparking coil. This method will not do, however, when we wish to produce big electric waves, far-reaching in their effects. We might, of course, increase



The Lodge-Muirhead System of Wireless Telegraphy—The complete set of Apparatus as supplied to the new Cable Repairing Ships.

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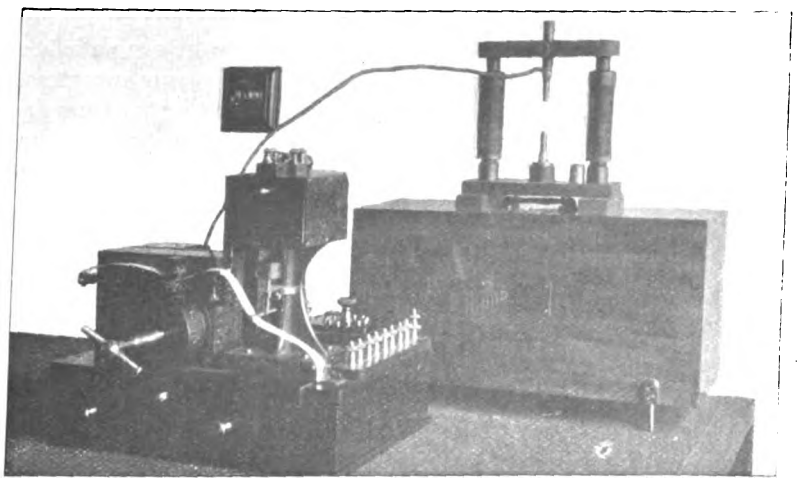
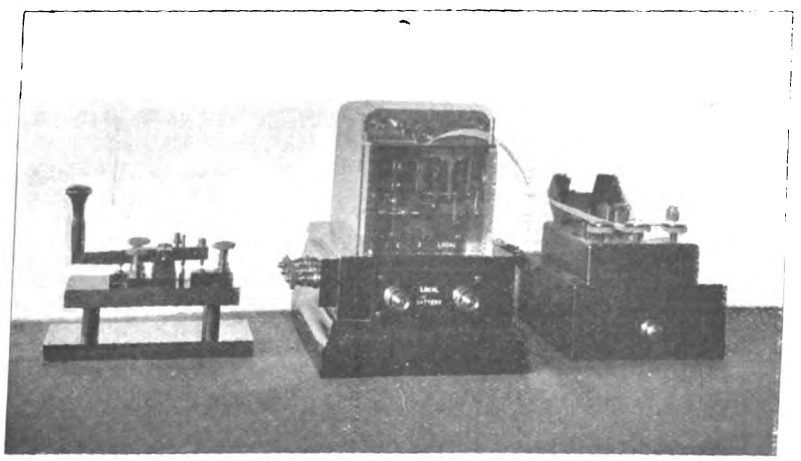
our spark gap very greatly. Of course the larger the spark in air the greater the pressure between the brass balls across which the oscillations take place. But such a process by increasing the resistance, finally causes the charge to lose its desirable oscillatory character. Consequently other devices have to be tried. One way is so to tune the receiver of the waves with the transmitter, that it is susceptible to them when they are very feeble. The feeble waves on arrival at the coherer exert a cumulative effect—just as one could set a very heavy pendulum swinging by giving it the tiniest taps, if these taps were administered at precisely the right intervals. Sir Oliver Lodge showed, some years ago, that if one had two tuned Leyden jars (our reservoirs) in which circuits were properly adjusted one to the other; then that a discharge in the one jar set up oscillations and an overflow with the other. But now we come to the second point. A discharge in a Leyden jar is



The Lodge-Muirhead System. Siphon Recorder and Coherer combined. Spark Gap on the right.

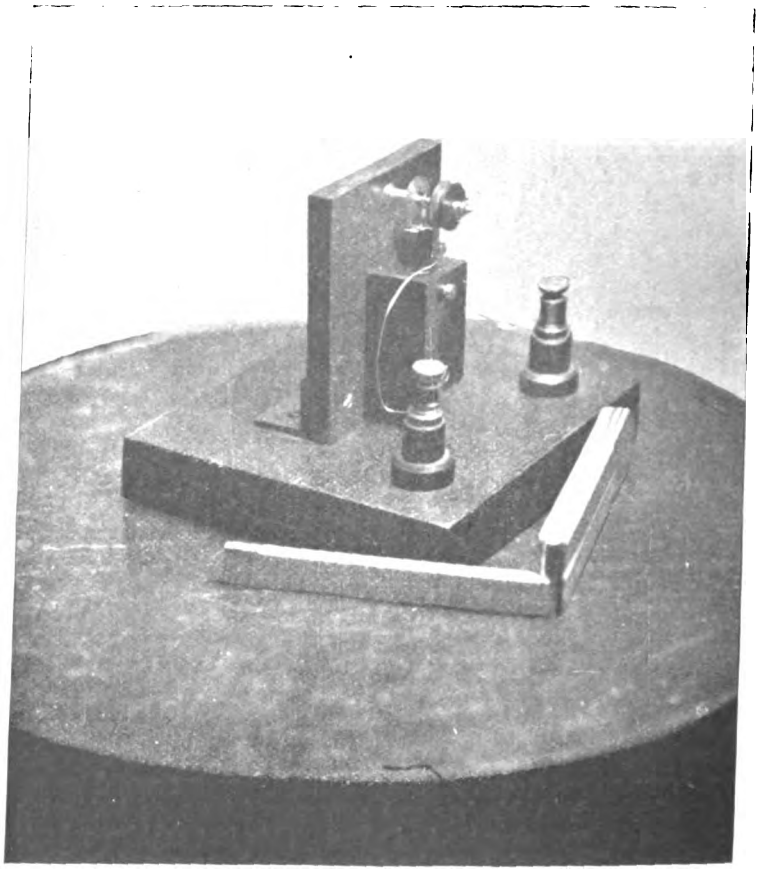
caused, let us say, by inequality of electrical conditions between the inside and outside of the jar. These minute differences and their consequent result are still too feeble for any considerable radius of transmission. Sir Oliver Lodge therefore extended his Leyden jars. He made them indefinitely large. He opened them out until their coats became parallel wires, or circuits, with a spark gap between them. We therefore have in the Lodge-Muirhead system a wire framework which supports the first aerial capacity, and lying on the earth the second capacity. A vertical wire connects them; and in some part of it is the spark gap served by the Ruhmkorff coil. We have thus our pump (the Ruhmkorff induction coil) pumping electricity into a reservoir which will produce not little overflows, but big overflows of electrical energy. Between the spark-gap and the lower capacity (or earth plate) are placed an inductance coil and a condenser, both adjustable, which



The Lodge-Muirhead System.
The Morse Key. The Automatic Transmitter. The Perforator.

serve for tuning this sending circuit or radiator to the required pitch. Sir Oliver Lodge and Dr. Muirhead have adopted other devices mentioned in their original patents six years ago (1897) for increasing the sensitiveness of the receiving circuit by multiplying the electro-motive forces as they reach the coherer or receiver of the waves.

Among the more important of the new details—which having been carefully worked out for several years by Dr. Muirhead, give to the system what is chiefly claimed for it, and that is dependability and serviceability—is the form of coherer. There are various kinds of coherers, of which the first and the commonest consisted, in principle, of filings of metals which were caused to cohere when Hertzian waves impinged on them, just as drops of rain cohere and rush together at the lightning discharges of a thunderstorm. When the filings cohere their electrical conductivity becomes altered, and thus a signal can be given. It is one thing, however, to have a coherer that will signal the advent of electric waves, and quite another to construct a coherer that is useful for unfailingly recording the dot and dash messages of the Morse Code. In the older form of coherers, the tube of filings had to be tapped every time the filings cohered in order to detach them from one another—to "de-cohere" them. The distinguishing feature of the Lodge-Muirhead system is that the coherer employed is a self de-cohering device. It consists of a small steel disc rotating in light contact with a column or globule of mercury contained in an ebonite tube, and covered with a thin film of mineral oil. As the Hertzian waves from the radiator arrive they break down the film of oil, and thus a momentary contact is established between the wheel and the mercury. The contact is sufficient to complete the circuit and enable the current from a local cell to operate a siphon recorder. The rotation of the disc, which is geared by ebonite wheels to the clockwork motion of the recorder, destroys the contact instantly without the intervention of any tapping apparatus. A felt pad lightly touching the steel disc cleans its edge of dust before and after contact, and renders it very sensitive in action. The coherer, as we have said, actuates a current which communicates directly with a siphon-recorder; and the simplicity and sensitiveness of the action of the coherer, together with the distinctness of the signals inked on the tape by the siphon recorder are really remarkable.



The Lodge-Muirhead System of Wireless Telegraphy.
The simplest form of Coherer.

Through the kindness of Sir Oliver Lodge, we are able to give an illustration of the simplest possible laboratory form of the new coherer (Fig. 5). There may be seen—a little too prominently shown—a wire leading from the binding screw to the mercury cap. There is also a sharp edged steel wheel dipping into the mercury, and a pulley on the same shaft by which it is kept revolving, say once a second or thereabouts, by a driving thread. An ordinary pocket foot-rule lies alongside, three inches to each segment, in order to show dimensions. This is, of course, not a real telegraphic instrument, but a sort of skeleton form of it, which, however, works extremely well.

We may return, in conclusion, to our transmitter of radiation As we have said, radiations are pumped into the condensers. They break through at the gap between the spheres of the aerial discharging rod. How are we to govern these discharges so as to correspond with the signalled dots and dashes, the short sparks and long sparks of the Morse Code. Dr. Muirhead has invented a form of electric interrupter—which is called a "buzzer"—and an automatic signalling machine to be used when preferred in place of the hand-operated Morse Key. We will consider the "buzzer" first. The "buzzer" consists of a pair of telegraphic sounders, or electro magnets, cross coupled so as to act reciprocally while the Morse Key is being held down. To the armature of one of the sounders an aluminium arm is fixed, with a copper rod dipping into a vessel of mercury, and thus making or breaking electric contact as it dips into the vessel or emerges from it. This make and break governs the sparking-coil, so that what the "buzzer" does is to break up the signals of the Morse Key automatically into a succession of sparks, the frequency of which can be adjusted so as to give the best results in transmission. In other words, the "buzzer" translates the dots and dashes of the Morse Key into oscillations at the sphere gap of

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appropriate frequency. These oscillations on arriving at the coherer are translated back by the syphon recorder into dots and dashes again. The extraordinary sensitiveness of the recorder and coherer combined—which is attained by turning the circuits one to the other—is such that the operators are enabled to detect the slightest inequality or uncertainty in the working of the transmitter.

In conclusion, we must express our great indebtedness to Sir Oliver Lodge, and Dr. Muirhead, and for invaluable assistance given us by Mr. H. C. Marillier.

Isolating Wireless Messages.

The great problem of wireless telegraphy has been, for some time past, and will still be in a more restricted sense, the problem of guiding and isolating wireless messages. It will be necessary to ensure that wireless messages from Station A will not interfere either with messages that are being sent from Station B, or that are being received at Station B. Some day we may hope that receivers will be constructed delicate enough and discriminating enough to be able to detect whence come the electric waves which reach them. At present the best form of coherer can only be described as a "rudimentary eye," which perceives the advent of electric waves, but is only just beginning to distinguish them.

Electrical Audition.

Professor Fleming, F.R.S., in some recent experiments at Poldhu, in Cornwall, has been endeavouring to find whether wireless telegraphy has solved the problem of sending a message which will be "heard" or received by one instrument, and will not be received by another. Professor Fleming, in his definition of electrical hearing, distinguishes between "hearing" and "not being able to help hearing." One might not be able to hear what was going on in the next room, and yet might be able to hear by putting one's ear to the keyhole. Similarly, an expert in wireless telegraphy might so adjust his receiving instrument that he could hear the messages being sent to another destination. But that was a very different thing from being in such a position that his receiving instrument could not avoid receiving messages from foreign sources. Professor Fleming declares positively that, in the first place, it was possible to construct receiving instruments so that they would respond only to the Hertzian waves intended for them. This was done by "syntonising" the receiver and the transmitter of waves. One can imagine in acoustics two tuning forks which, tuned to the same note, might set one another vibrating—the simile has given rise to the word "syntony"—and the analagous principle has been some time known in electrical vibrations. Professor Fleming has shown it actually in action by placing two parallel electric circuits near one another, one of which had a spark gap, and the other of which embraced a little electric lamp which glowed when a current was induced in it by the action of the first current. At first the circuits were not "tuned," and the glow lamp would only light at a distance of eighteen inches. A Leyden jar was then put into the second circuit, to bring the two circuits to the same electric resistance—and now the glow lamp was started at five times the distance. That is the principle which on a larger scale has been applied after many experiments to long-distance wireless telegraphy.

Conclusive Tests.

There is, at Poldhu, the electrical transmission station by which Mr. Marconi sends messages across the Atlantic. In the same field with it is a small ship-to-shore transmitting apparatus. Professor Fleming wrote out and sealed sixteen messages, some of them in cipher, and the contents of all of them known to himself. These messages he entrusted to his assistant, with orders that they were to be opened at the times written on them only, and transmitted from the big power-station, and from the little ship-to-shore station concurrently. The intention was to see whether the big installation, hurling its electric waves like an etheric foghorn over the Atlantic and across Europe, would interfere with the little ripple of the small transmitter sending its messages to a station six miles away. Professor Fleming, having put everything in order, and satisfied himself that the big machine was booming its hardest, then drove off to the Lizard, six miles away. Here the messages began to come in, and Mr. Marconi read them off on the tape as they were reeled off, without a single failure or hesitation. Certainly the little messages came in uninterrupted by the big waves. But how, someone might ask, did they know that the big waves were being transmitted all this time? There was a special arrangement made for that. The big waves were going on to the wireless station at Poole, 200 miles away; and when they arrived there were being re-telegraphed by the Post Office, so that an absolute check was being kept both by Professor Fleming and by the Post Office repetition of messages sent by the big apparatus to Poole, and contemporaneously by the little apparatus to the Lizard. For instance, at 3.15 the ship-to-shore station sent out "Financial situation in New York is to be suspected. I advise you to close your account"; and at the same time the big 28-horse power station was sending on to Poole, "The crop is expected to be about the average. Strongly advise you to sell immediately"; and five minutes after this second message had ceased to be sent, it was being re-transmitted by Post Office telegraph to Poldhu. Thus "freedom from interference," if not absolute privacy, may now be regarded as established, and the result is of the highest importance to the future of wireless telegraphy.

Life from other Worlds.

By Dr. Bryan, D.Sc.

To account for the existence of organic life on our planet, many theories of a highly speculative character have been put forward. The idea that terrestrial life owes its origin to an invasion of germs from outside, carried on the back of meteorites, is no less fantastic than Mr. H. G. Wells's tale of "The Martians." A suggestion has lately been current in certain scientific and popular journals to the effect that germs may be floating about in space in the form of cosmic dust. This suggests the old superstition according to which diseases are sent to us from above as a punishment for our sins! Unless such theories are discussed in their physiological as well as their physical aspect, a rolling stone may have been started in the form of a fallacy which can hardly be stopped in a century.

Now, from a physiological point of view, any theory which implies community of life between our world and other worlds must be received with extreme caution. The nature and origin of terrestrial life were investigated in 1899 by Dr. F. J. Allen, who stands alone among English physiologists in the attention he has been giving to this problem. Dr. Allen's views are receiving much attention in Germany, and several books and papers on the subject have lately appeared in that country.

Life such as it exists on the surface of our earth depends on the presence of the four elements nitrogen, carbon, oxygen, and hydrogen, at a temperature confined between certain limits. The processes of life depend essentially on the building up and breaking down of the innumerable complex compounds which can be formed with these four elements between the temperature limits in question, and which form the basis of the difficult subject of organic chemistry.

The biochemist knows that there is no other world, in our solar system at least, whose physical conditions suggest any possibility of supporting life known to us. On the other hand, Dr. Allen considers that the idea of community of life shows a very contracted view of the nature of life. We are not justified in supposing that life is confined to that material which the uninitiated call protoplasm. Different worlds may produce different characteristic forms of life, each depending on the peculiar prevailing physical conditions and available elements. It is absurd to look for chlorophyll bands in the spectrum of Mars, or to talk of vegetation on the moon. Vegetation, chlorophyll, animal, and germ are earthy phenomena which may exist nowhere else, though equally marvellous phenomena may take their place.

A terrestrial germ, accustomed to working with nitrogen, carbon, oxygen, and hydrogen at temperatures between 0° and 40° would be as out of place on Venus or Jupiter as an inhabitant of these planets would be on our earth.

Another widespread fallacy is that the beginning of life was a cell. The cell is a very compound organism, and its origin must mark quite a late, perhaps comparatively recent, stage in the evolution of living beings. As Dr. Allen points out, it is conceivable that all uncellular organisms may in the future be annihilated in the struggle for existence as pre-cellular organisms have been, almost or quite completely. Then some post-human investigator may similarly assume that the beginning of life was a crustacean or shell-fish!

Electric Traction Without Conductors.

It appears to be quite within the range of possibility that we may in a few years be able to run our electric trams, trains, ships, and other machinery without conductors, and from power generated many miles away. In other words, what Marconi has done with wireless telegraphy other inventors will do with electric power. The idea is not new. Tesla, if we remember rightly, promised something of the sort years ago, but, like many other of his promises, it at present remains unfulfilled. The new inventor is Mr. T. H. Williams, A.M.Inst.C.E., who has been interviewed on the subject by a representative of the *Westminster Gazette*. Mr. Williams appears to have carried the wireless current idea a stage further in applying it to electric traction. His model car runs on rails, and is provided with a "collector" to pick up the electric waves sent out by a distant generator, instead of a trolley, to transmit the current from a wire to the motor. The whole thing, of course, as we have said, is a logical extension of the principle of wireless telegraphy, and tramway committees, like the cable companies, will now, we suppose, have to face the possibility that their third rail or what not may sooner or later become useless. Indeed Mr. Williams is said to foresee the application of his system to ordinary motor cars, running on the road, and suggests that a generating station for every hundred miles of highway could supply sufficient power to all the vehicles within range. It is evident that if Mr. Williams's discovery should fulfil his sanguine expectations a vast addition would be made to the resources of civilization. Railway trains would no longer want locomotives, and sea-going vessels would work their machinery by ether waves transmitted from their port of departure. More wonderful still, the problem of aerial navigation would solve itself, for the new power, being generated on terra firma, would enable air-ships to make their voyages without the dead weight of the generating machinery which at present clogs their flight and defeats their efforts.—*Machinery Market.*

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Projectiles & Armour Plate.

A continuous duel goes on between the metallurgist and the gun-maker, the one trying to produce armour which shall not be pierced by the projectile, and the other trying to find a projectile and a propulsive force for the projectile which shall break through the strengthened armour. A diagram might be drawn showing how at one period the projectile triumphed, and how at another the armour was so strengthened by metallurgical science that the projectiles broke against it in vain. In the last decade but one of the nineteenth century the armour plate, strengthened by a new method of manufacture began its period of triumph.

A plate was submitted by Messrs. Vickers in 1888 which was not a compound plate but a plate of solid "carbonised" steel, that is to say, steel with about one-third carbon. The plate measured 8 ft. by 6 ft., and was 10½ inches thick. It was attacked by 6-inch guns, whose muzzles were only 30 ft. distant from the plate; and the guns were fired with full charges. The velocity of the shot would be 1,967 ft. a second; it would strike the plate with an energy of 2,723-foot tons. In no case did the shot penetrate the plate. This was the beginning of the use of "carbonised" steel plates, and the trial, which is historic, was on board H.M.S. *Nettle*.

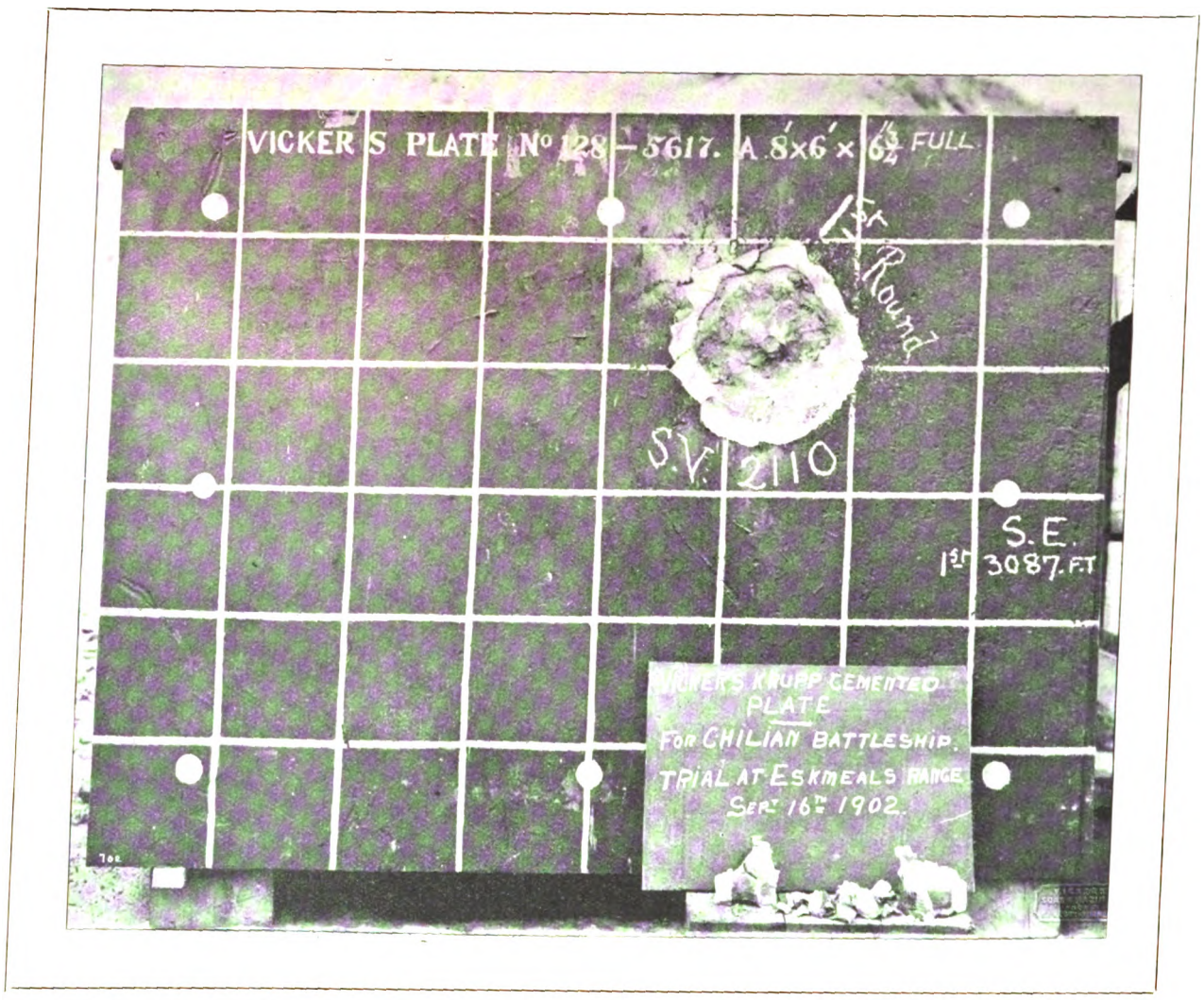
The second step was the introduction of nickel into the plate. A plate of the same size as before was made with this alloy (2 per cent. nickel), and tried in 1892. The plate fired at with the same projectiles and guns as before was cracked a good deal, but not penetrated.

The next test was with a nickel-steel plate treated by the Harveyising process, that is to say, by first carbonising and then hardening by chilling. The plate gave much better results than the nickel plate tried a year before. There were no cracks on the plate, it was nowhere pierced, there was no bulge on the back, and the projectiles were smashed up into fine pieces. So the plate was put to a severer test. The 9.2-inch gun at Shoeburyness was brought to bear on it, and fired at it with projectiles that hit its face with a blow of 7,595-foot tons. The projectile weighed 379 lbs. It bored its way into the plate 6 inches deep; but could not get through, and broke up. A still severer test was applied, the striking energy being increased to 8,116-foot tons, but still the shell could not get through.

This is hardly the place in which to go through the various improvements, which, since that day, have been made in the resistant powers of steel plates since the nickel-steel Harveyised plates first began their triumphant career. They have improved more than a hundred per cent. on their first achievements. At the same time guns and projectiles have been improved, and one of the notable improvements has been that of tipping the projectile with what is known as the Johnson cap. The latest stage of development both of armour plate and projectile may be gathered from the accompanying photograph, furnished by the courtesy of Messrs. Vickers, Sons, and Maxim, of the trials of armour plate of the latest-built battleship, the Chilian *Libertad*.

The armour plate was 6¾ inches thick. The first shot fired at it from a 6-inch gun at the usual short distance struck it with an energy of 3,087-foot tons. The shot penetrated barely two inches, and was completely broken up. A second shot had a precisely similar effect.

For the third shot, the Vickers' projectile was fitted with a Johnson cap. Its weight then was 107 lbs., and it was fired with a 15-lb. charge of cordite so as to strike the plate with an energy of 3,323-foot tons. The Johnson cap did its work. There was a complete perforation of the plate, the backing, and the skin plate. The projectile was broken up in several large pieces, most of which were found in front of the plate. A piece of the plate was punched through the backing (of five feet) and the skin plate, and was picked up 38 feet away.



Armour Plate and Projectile—The first round.

Then two rounds more were fired similar to rounds (1) and (2), and again the shots were all broken up without cracking the plate.

For the last shot, the projectile, a 7½-inch shell fitted with the Johnson cap, and weighing 204 lbs., was fired so as to hit the plate with an energy equal to 6,301-foot tons. The shell broke up; its point and base plug were found 20 feet away; but it all passed through the hole it made in the plate. The plate, resistant to the end, however, still showed its quality by displaying no cracks.

The cap which is fitted to shells, it may be explained, consists of a sort of rim of soft steel fitted on the extremity of the shell, and this is supposed to prevent injury to the nose of the shell on impact, and to take up the force of the blow, which might otherwise blunt the point of the shell, while leaving the projectile free to subsequently exercise its destructive powers.

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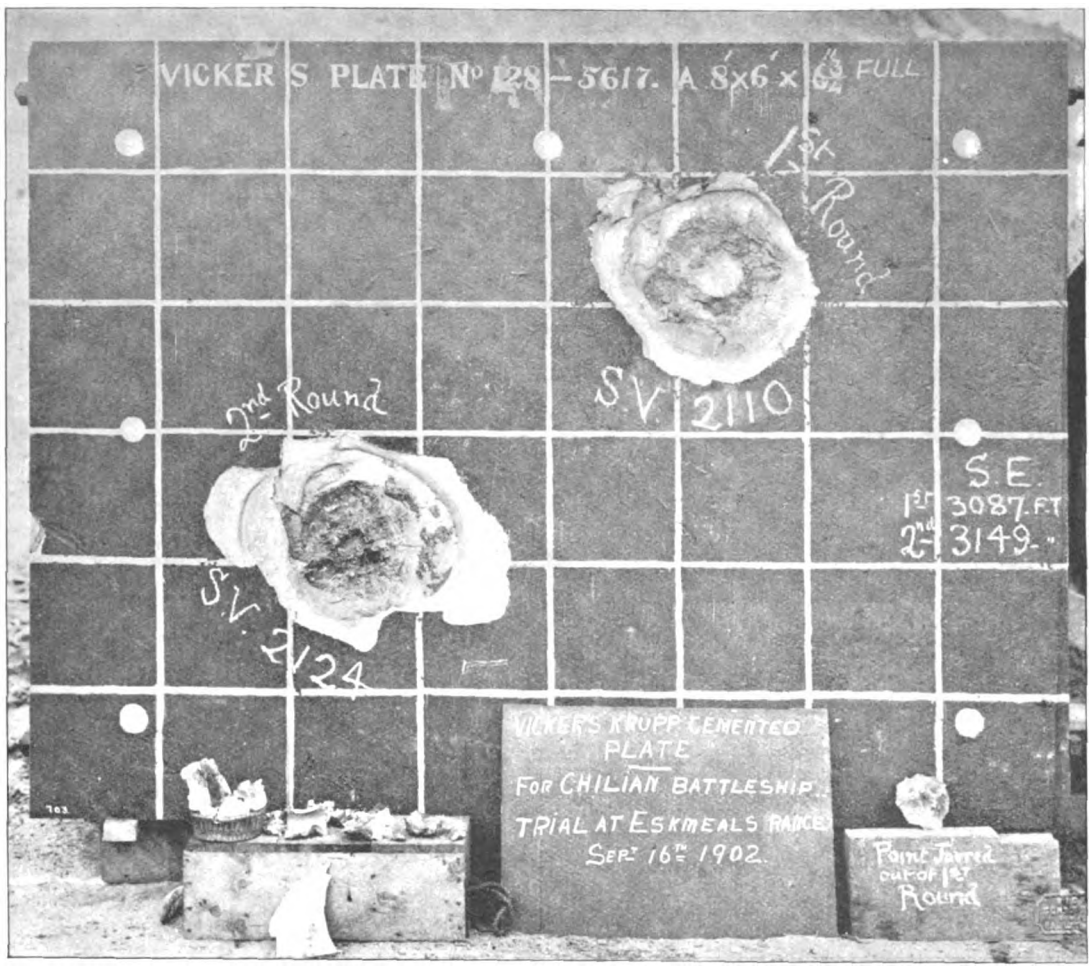
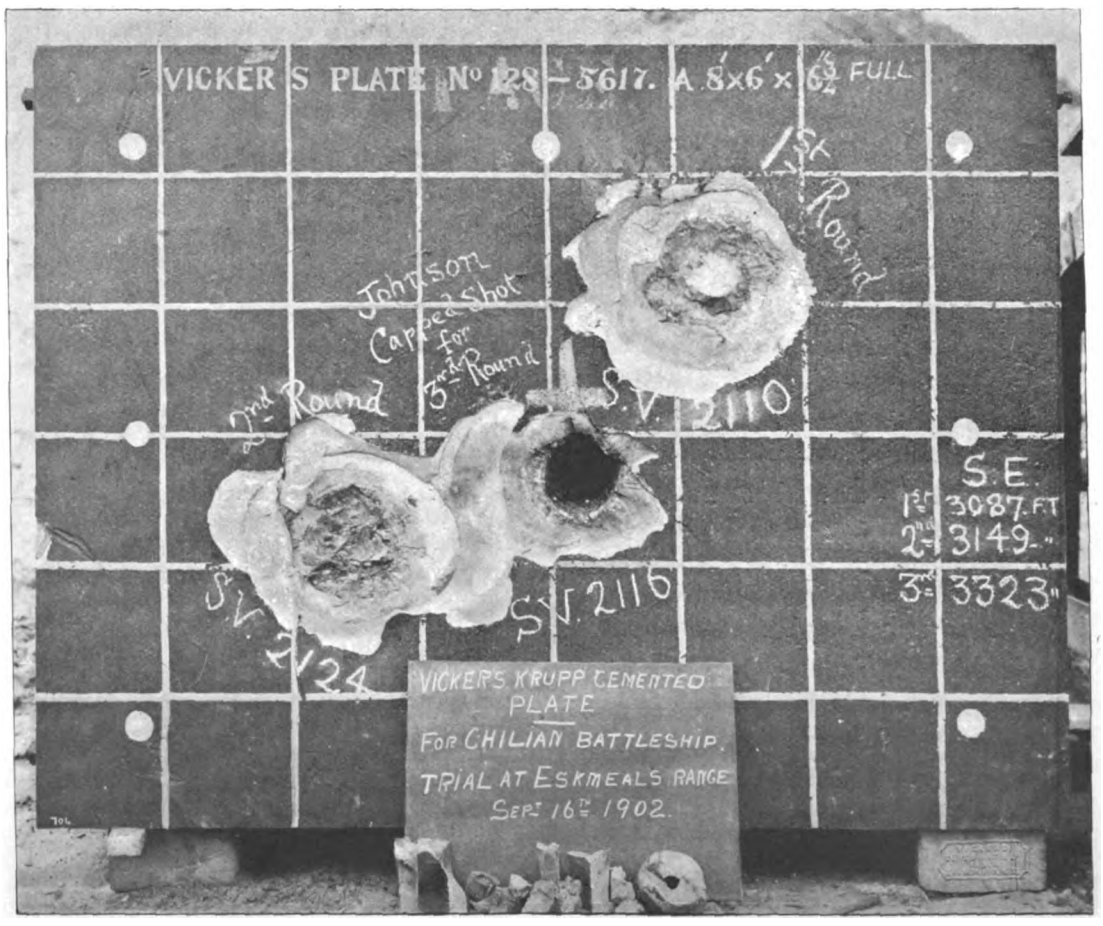


Armour Plate and Projectile--The second round—Pieces of shell below.



Armour Plate and Projectile—The third round—Plate pierced by Capped Shell—pieces of shell below.

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Napoleon and the Metric System.

In last month's Illustrated Scientific News mention was made of an extract read by Sir Frederick Bramwell from some French memoirs, which embodied the views of Napoleon on the Metric System. Through the kindness of Sir Frederick Bramwell, we have obtained a copy of his translation of the passage referred to :—

Memoirs to Serve in the History of France under Napoleon.

Written at St. Helena, by General Comte de Montholon.

1. The need of uniformity in weights and measures has been felt throughout all ages; several times the Etats Généraux have alluded to it. It was expected the Revolution would achieve this unification.

2. The law needed for this matter was so simple that it could have been written out in 24 hours, and could have been adopted and put into practice throughout the whole of France in less than a year. All that was required was to make the units of weights and measures of Paris the only legal units throughout France.

3. The Government, the Artisans, had for generations past used these weights and measures. By sending standards to every Commune, and by ordering the Administration and the tribunals not to recognise any others, this reform would have been carried out without trouble, inconvenience, or coercive measures.

4. The geometers, the algebraists, were consulted in a question which was, in fact, purely one of an administrative character. They thought that the unity of weights and measures should be deduced from some natural order, so that it might be adopted by all the nations.

5. They were of opinion that it would not suffice merely to do good to 40 millions of men, they wished the whole universe to participate.

6. They found the mètre to be an aliquot part of the meridian. They proved it (to their own satisfaction), and proclaimed it in an assembly of French, Italian, Spanish and Dutch geometers.

7. A new unit of weights and measures was immediately decreed which neither "fitted in" with the regulations of the public services, not with the "rules and tables" of the manufacturers, nor with the dimensions of any existing machine.

8. Moreover, as a fact, the advantages of this system could not extend to the whole universe. It was impossible. The national spirit of the English and of the Germans was opposed to it.

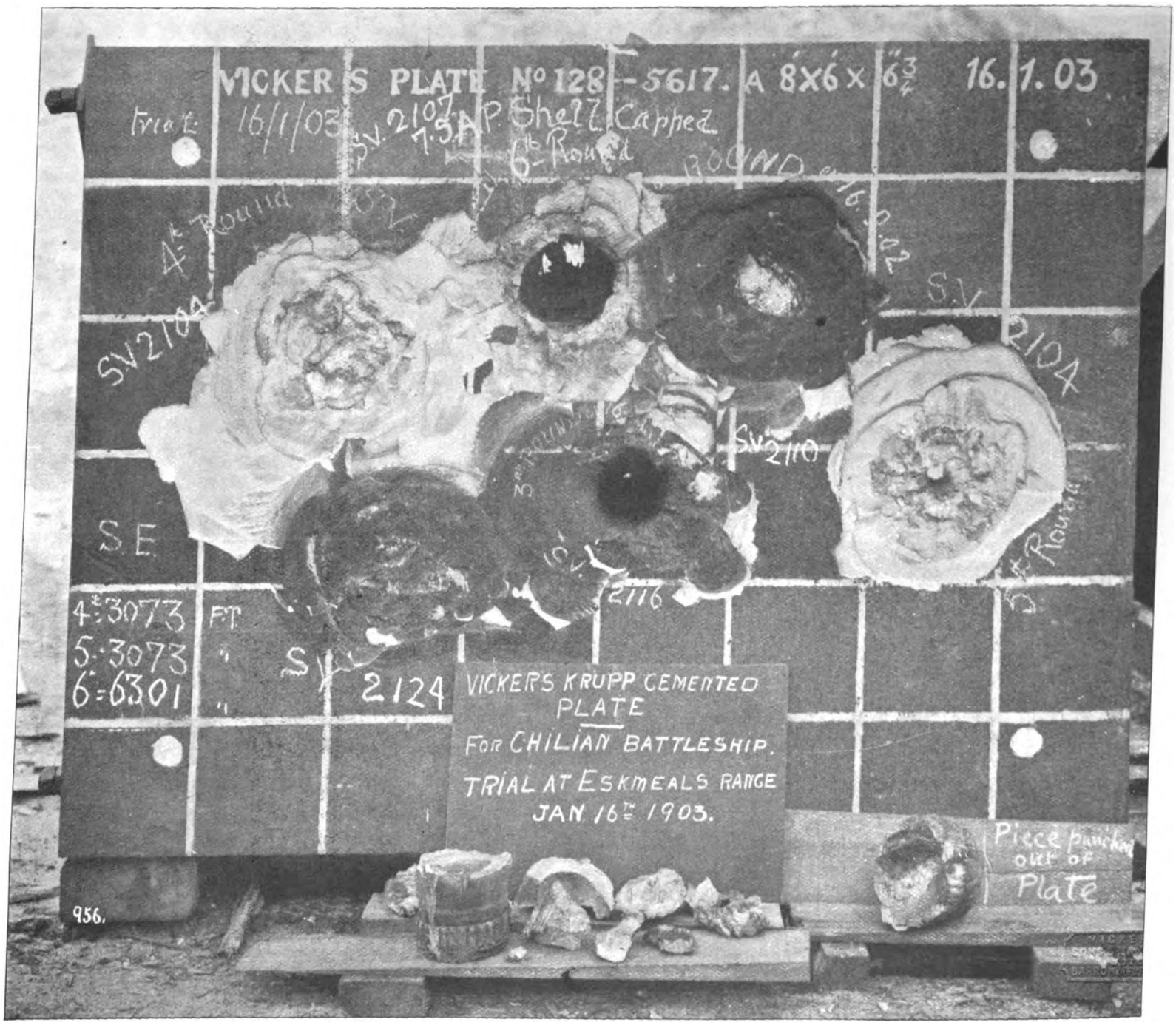
9. If Gregory VII., in reforming the Calendar, was able to render that reformation universal throughout Europe, it was because this reform was connected with religious ideas; that it had not been made by a nation, but by the power of the Church.

10. Thus the comfort of the present generation was sacrificed to abstraction and to vain hopes, because, for an old nation to adopt a new unit of weights and measures, it is needful to remake all rules of public administration, all the calculations used in the Arts. Such a work alarms the reason.

11. The new unit of weights and measures, such as it was, had an ascending and a descending scale, which did not tie in by simple numbers with the scale of the units of weights and measures which for centuries has sufficed for the Government, the scientific men, and the manufacturers.

12. The translation cannot be made from one to the other system, because that which is expressed by the most simple numerals in the old system demands, in the new, composite figures.

13. It became necessary, therefore, either to increase or diminish, by some fractions, in order that the measurement, or the weight, when expressed in the new nomenclature, should be in simple figures.



Armour Plate and Projectile—After six rounds—The Plate twice pierced by Capped Shell—fragments of shell below.

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14. Thus, for example, a soldier's ration is expressed in the ancient nomenclature as 24 oz. This is a very simple expression; translated into the new, it gives 734 grammes 259 milles.

15. Thus it is evident that to arrive at the whole numbers (734 or 735 grammes), there must be augmentation or diminution.

16. All the pieces and lines relating to architecture; all the tools and the parts used in clockwork, in jewellery, in publishing, in all the Arts, in all the instruments, in all the machines, had been studied and calculated in the ancient nomenclature, and are expressed by simple numbers, while the translation needed numbers composed of five or six figures; thus all must be done over again. The "Savants" conceived another idea, altogether nullifying the benefits of unity of weights and measures, for they adopted in their scheme the decimal numeration; they took the mètre as their unit, and they suppressed all other starting points.

17. Nothing can be more contrary to the organisation of the mind, the memory, and imagination.

18. A fathom, a foot, an inch, a line, a point ($\frac{1}{12}$ of a line), are fixed portions of length, which the imagination readily conceives independently of their relation to one another. If, therefore, one asks for one-third of an inch, the mind operates immediately; it is a portion of length called an inch which is to be divided into three equal parts.

19. By the new system, on the contrary, it is not the operation of dividing an inch into three which has to be performed by the mind; but it is the division of a mètre into 111 parts. The experience of ages has shown the difficulty of dividing a distance or a weight beyond 12, for at each of these divisions there has been created a new "term" or starting point.

20. If one wanted the $\frac{1}{12}$ part of an inch, the operation was already made; it was the "term" "ligne."

21. Decimal numeration could (under the old system) be applied to all the "terms," and if a hundredth of a "point" or of a "ligne" was required, one wrote $\frac{1}{100}$th; but if one wishes to express a hundredth of a "ligne" by the new system one has to consider its relation to the mètre, which causes endless calculation.

22. The divisor 12 has always been preferred to the divisor 10, because 10 has only 2 factors—2 and 5; while 12 has 4, viz., 2, 3, 4 and 6. It is true that the decimal numeration, generalised and exclusively adapted to the mètre as unity, affords facilities to astronomers and to mathematicians, but these advantages are far from compensating for the inconvenience of rendering the thinking-out more difficult.

23. The first object of every method should be to aid conception and imagination, to assist the memory, and to give greater power to the mind.

24. The various "terms" are as old as man, because they are in the very nature of his organisation, just as it is in the nature of decimal numeration to adapt itself to each unity, and to each "term," and not to one unit exclusively.

Further, these scientific men used Greek roots, thereby augmenting the difficulty. Such denominations, though they may be serviceable to the scientists, are not good for the public.

The "weights and measures" were among the great affairs of the Directoire.

Instead of leaving it to the influence of time, and of contenting themselves with encouraging the new system, by means of example and of custom, they made coercive laws, which were executed with vigour.

The merchants and the people found themselves harassed for that which was in fact a matter of indifference. This contributed still further to make unpopular an Administration which placed itself aloof from the wants and the powers of the people; which violently broke their practice, their habits, and their customs; just as might have been done by a Greek or Tartar conqueror, who, with the rod of power uplifted, enforced obedience to his will, who commanded according to his prejudices and his interests, regardless of those of the vanquished.

The new system of weights and measures will be the source of embarrassment and difficulty for many generations, and it is probable that the first scientific commission to whom it is given to verify the measurements of the meridian will find some corrections to make. It is a tormenting of the people for mere trifles.

Astronomical Notes for April.

The Sun.

On the 1st the sun rises at 5 h. 39 m. a.m. (G.M.T.), daybreak occurring 2 hours and 2 minutes earlier; the time of sunset on the same date is 6 h. 29 m. p.m., twilight lasting the same period in the evening as in the morning hours. The day will therefore be 12 hours and 50 minutes in length. The Sun's declination *north* at noon on this day will be 4° 11′ 37″, with an hourly variation of 58″·04.

Sunspots may be looked for with more hope of success than in the past month.

The Moon.

Our satellite will attain her first quarter on the 5th, at 1 h. 51 m. a.m.; becomes full on the 12th, at 0 h. 18 m. a.m.; reaches her first quarter on the 19th, at 9 h. 30 m. p.m.; and will be new again on the 27th, at 1 h. 31 m. p.m. She will be in perigee on the 5th, and in apogee on the 19th.

On the first day of the month the Moon will set at 10 h. 44 m. p.m., and it is when she is at or about this age (3 days) she makes a very attractive object soon after sunset, as seen through a field-glass or small telescope, a faint light being often traceable right round the dark limb of the Moon plainly visible by "earthshine."

Two occultations of fixed stars will occur during the month, suitable for amateur observation. The first of these will take place on the 3rd, when 130 Tauri (magnitude 5·5) will disappear behind the moon at 6 h. 47 m. p.m., at 128° from the true north point, and will reappear just 57 minutes later at 239° from the same point. The other occultation is of a more conspicuous star, viz.: υ Leonis (magnitude 4·5), the disappearance taking place at 11 h. 48 m. p.m., and the reappearance 35 minutes subsequently, at 177° and 233° from the true north point respectively.

There will be a Partial Lunar Eclipse on the 11th, visible at Greenwich. The Moon will rise at 6 h. 26 m. p.m., and the first contact with the *penumbra* will occur at 9 h. 28 m. p.m., whilst that with the *shadow* will take place at 10 h. 34 m. p.m. The middle of the eclipse will be reached 13 minutes after midnight, when, if we take the Moon's apparent diameter as *unity*, 0·973 will represent the magnitude of the Earth's shadow, so that it will be seen that this eclipse will approach in point of interest very nearly to a total one. The last contact with the *shadow* is timed for 1 h. 52 m. a.m. on the 12th, when the eclipse will virtually be over, though the Moon, however, will not be finally clear of the *penumbra* until more than an hour later.

The Moon will be in conjunction with Mars on the 10th, Saturn on the 20th, Jupiter on the 23rd, Mercury on the 28th, Venus on the 30th.

The Planets.

Mars remains a conspicuous evening object, rising on the 15th at about 4 h. 30 m. p m. He is still situated in Virgo, being near to the star η of that constellation.

Venus continues to move away from the Sun, and becomes gradually a more and more brilliant object in our evening skies. By the 26th she will have attained a northern declination of 23° 19′ 53″, and will set at about 10 h. 30 m. p.m., fully ten degrees north of and more than 3 hours later than the Sun.

Mercury will be in too great proximity to the Sun for observation until nearly the end of the month, when, however, a very favourable opportunity for his identification presents itself, the planet being situated but 5° north of the Moon on the 28th, and not setting till about 9 h. p.m., with a northern declination of about 20°.

Jupiter and Saturn are "morning stars," but as they rise at between 3 h. and 4 h. a.m., can scarcely be said to be *conveniently* placed for general observation.

Uranus is still very unfavourably situated, having a southern declination of over 23°, and not rising until past one o'clock in the morning.

Neptune is practically in the same position as last month, but as he "souths" two hours earlier, is even less favourably placed for observation.

Of the *minor planets*, Juno is now coming into the amateur observer's field of view, as she is rapidly approaching opposition. On the 26th she will rise at 8 h. 31 m. p.m., with a southern declination of only 5° 8′ 54″, and this is lessening daily. Her right ascension on the date given will be 16 h. 23 m. 52 s.

The Constellations.

At the commencement of the month at about 10 o'clock in the evening, Leo will be in evidence to the southward on the meridian. This interesting constellation may be roughly divided into two parts, the "triangle" and the "sickle," the latter conformation marking the head of the lion, and the former constituting the hind quarters.

All the southern constellations mentioned in last month's notes will be found rapidly approaching the western horizon. To the eastward Boötes, with Arcturus as its chief star, is now in a fairly elevated position. To the south-eastward is Virgo, with Spica as its most conspicuous object, not very far from the planet Mars, whilst below this, Hydra stretches its sinuous length to the south-south-east along the horizon.

Our old friend, the Great Bear, is now exactly overhead, whilst Ursa Minor, Cassiopeia, and Andromeda (the last-named group skirting the horizon) will be found below it to the northward.

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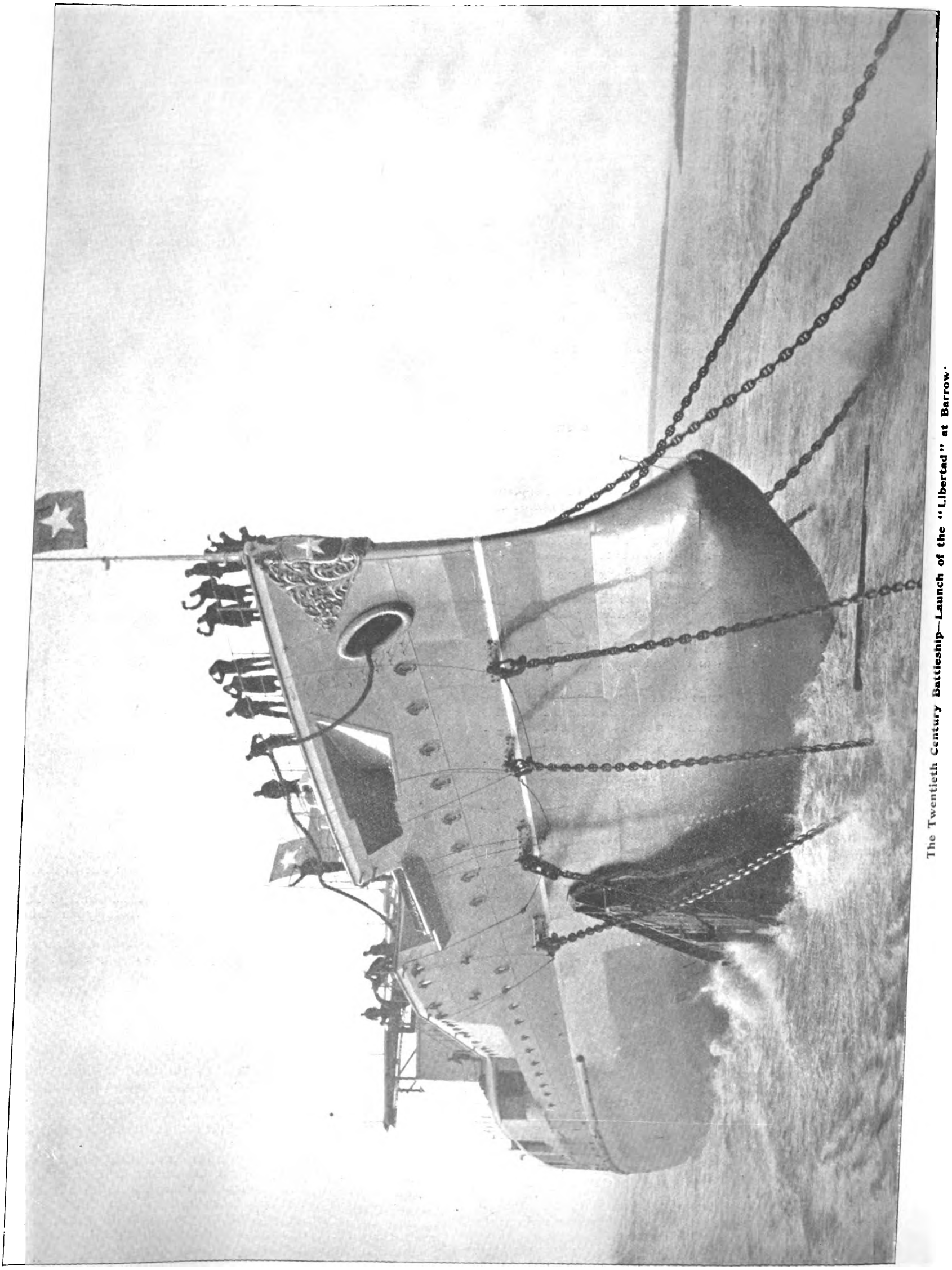

The Twentieth Century Battleship—Launch of the "Libertad" at Barrow.

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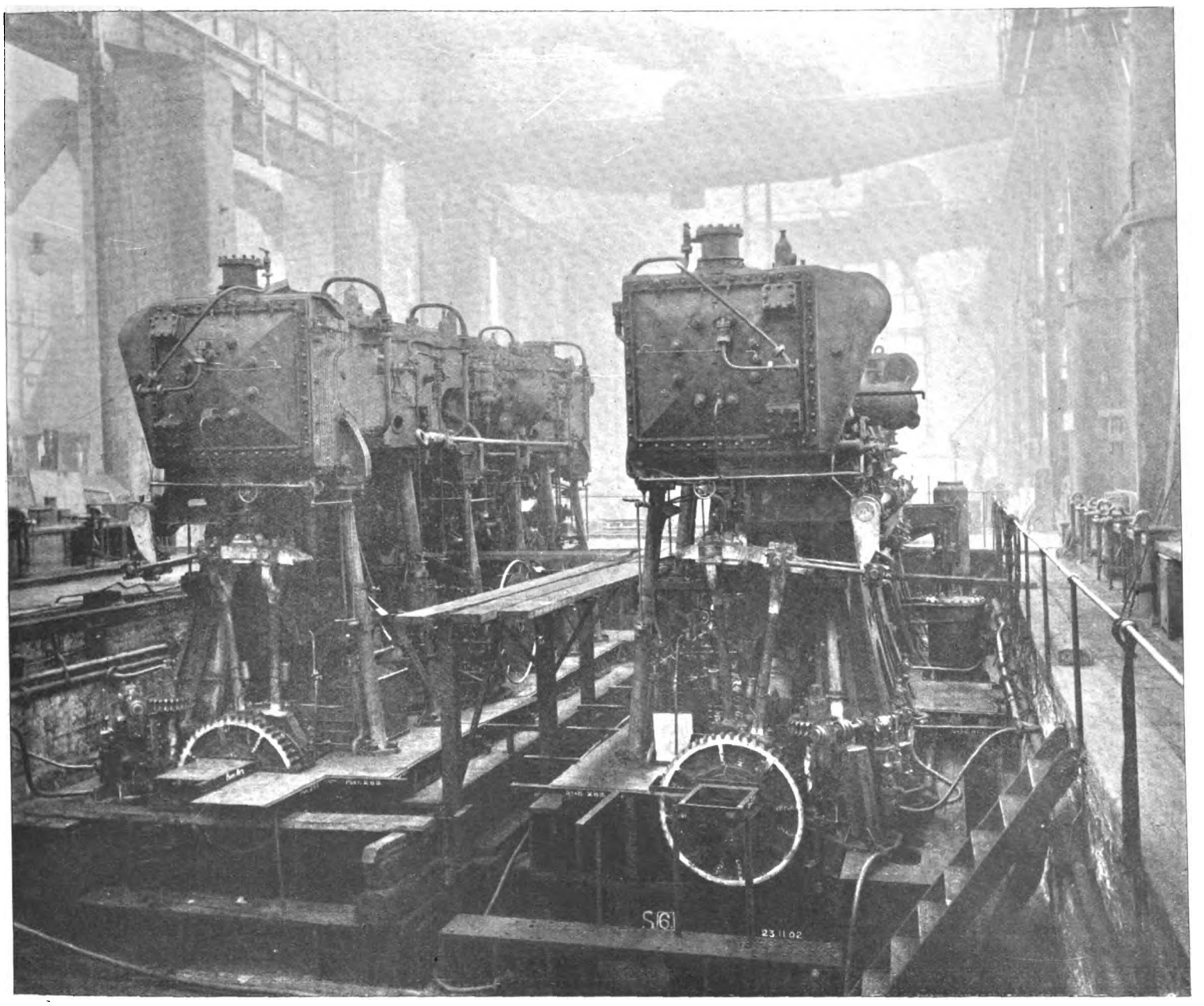
The Twentieth Century Battleship.

Through the courtesy of Messrs. Vickers, Sons, and Maxim, we are enabled to reproduce photographs of the launching and of the engines of the Chilian battleship *Libertad*, which is, for her size, the most powerful fighting ship afloat. The *Libertad* is 11,800 tons, and has many claims to be regarded as the highest product of the fighting machine that has ever been launched. Whatever developments of destructiveness the next hundred years may have in store, the *Libertad* is at the present moment the highest type of the twentieth century battleship. The photograph of her launching is worthy of the ship—she has been caught at the very moment when the heavy chains hanging from her bow were beginning to check the vessel's way through the water. The launch took place this year from the yards of Messrs. Vickers, Sons, and Maxim, Barrow-in-Furness.

The *Libertad* is 436 feet long and 71 feet broad, and her mean draft is 24 feet 7½ inches. Her motive power consists of Yarrow boilers of the large-tube type, and twin-screw, triple-expansion engines of 12,500-horse power, and her estimated sea speed is 19 knots an hour. The normal coal capacity is 800 tons, but the full bunker capacity is 2,000 tons. The vessel will carry a complement of 700 officers and men.

The armament consists of four 10-inch breech-loading rifles with quick-action breech mechanism; fourteen 7.5-inch rapid-fire guns, fourteen 3-inch rapid-firers; four 6-pounders; four Maxims, and three submerged torpedo tubes; and from this heavy battery it is estimated that with all the guns firing at their maximum speed, this vessel could deliver in one minute 13½ tons of metal whose combined energy would amount to 1,700,000 foot-tons. In explanation of this great total, it is sufficient to mention that the guns are all of the modern, long-caliber, high-velocity type, with the latest pattern of breech mechanism designed to facilitate rapid loading. Thus, the 10-inch guns will fire a 500-pound shell with a muzzle velocity of 2,850 feet per second and a muzzle energy of 28,160 foot-tons. At the muzzle these guns will be capable of penetrating 31 inches of steel armour. The 7.5-inch gun of the broadside battery is a 50-caliber piece, which fires a 200-pound shell with a muzzle velocity of 3,018 feet per second, and a muzzle energy of 12,638 foot-tons. This piece, which can fire eight rounds per minute and has, therefore, about equal rapidity of fire with the 6-inch piece, can penetrate at the muzzle nearly the same thickness of steel plate as the 10-inch gun, or 29.4 inches. The adoption of such a heavy gun for the secondary battery is in accordance with the best modern practice, which recognises that the 6-inch piece is not sufficiently powerful to penetrate the modern Krupp armour with which the secondary batteries of modern warships are protected. This 7.5-inch gun, however, is capable of effecting penetration at ordinary battle ranges, and therefore marks a great advance on the secondary batteries carried by most existing warships and cruisers.



The Twentieth Century Battleship—A Set of Engines of the "Libertad."

The defensive features of the *Libertad* are hardly less remarkable than her tremendous powers of offence. She carries a practically complete belt at the water line which has a maximum thickness of 7 inches amidships and is associated with athwartship screen bulkheads 10 inches in thickness. This belt is 8 feet in depth. Side armour of the same thickness extends to the upper deck over the whole side of the ship lying between the two main barbettes, and by its association with transverse bulkheads of 6-inch armour, it forms a complete armoured central citadel. The upper deck is formed of 1-inch steel plating, while the protective deck, which is 1½ inches in thickness within the citadel and 3 inches in thickness at the ends outside the citadel, extends completely from stem to stern at the level of the top of the waterline belt. The barbettes for the 10-inch guns are 10 inches in thickness in the front where they project beyond the central citadel armour and 8 inches in the rear. The 7.5-inch guns are carried, four of them in casemates on the upper deck at the four corners of the central citadel, and the other ten are within the citadel on the gun deck, five on either side. This battery of ten guns is further protected by 1-inch screens of steel plating placed transversely between each

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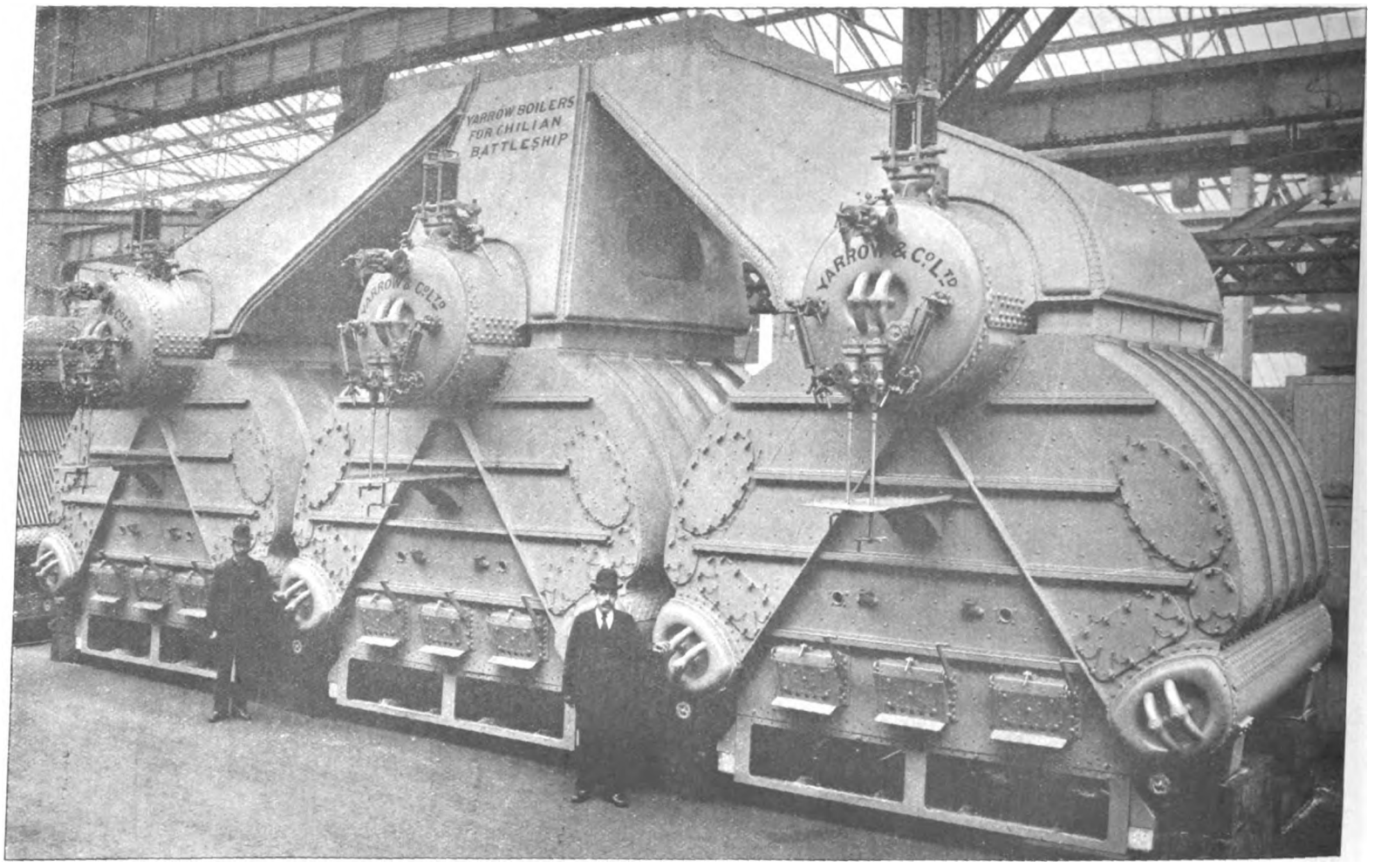
pair of guns. This battleship will be considerably the most powerful war vessel in the Chilian fleet, which possesses some of the most notable armoured cruisers in existence.

Not the least remarkable feature about the *Libertad* is the great speed at which she has been built. The first keel plate was laid March 13, 1902, and the launch took place on January 6, 1903, the vessel being therefore completed in the remarkably short space of ten months.

The *Libertad* was fitted by Messrs. Vickers, Sons, and Maxim with Yarrow boilers. The horse power of the ship's machinery is 12,500 I.H.P., and there are twelve boilers of the large-tube type, placed in groups of three, as illustrated in the engraving, in four separate water-tight compartments. In each of these stokeholds there is a feed-pump, fan, ash-ejector, and ash-hoist. The height of the two funnels is 90 ft. above grate level, and the diameter is 10 ft. 6 ins. over the casings.

This type of boiler is being largely adopted. The Austrian Navy have now built, or have in course of construction, three battleships, and four cruisers with Yarrow boilers aggregating 77,900 indicated horse-power. In the Dutch Navy there are three cruisers, each with three-fourths of the boiler installation of the Yarrow, and the remaining one-fourth of the cylindrical type, while three other cruisers and three coast-defence ironclads are entirely supplied with steam from boilers made by the Poplar firm, the total horse-power being 70,500 indicated horse-power. Two Norwegian battleships add 9,000 indicated horse-power to the list, a Portuguese cruiser 12,500 indicated horse-power, and seven Sweden ships 39,000 indicated horse-power, so that foreign warships, excluding torpedo craft, represent a total of 233,900 indicated horse-power, to which there falls to be added 53,200 indicated horse-power for British warships.



The Twentieth Century Battleship—Yarrow Boilers for the Chilian Battleship "Libertad."

Biltong.

During the recent war in South Africa much was heard of the remarkable qualities of the sun-dried meat which formed so important an element in the commissariat of the Boers. Prof. Halliburton, F.R.S., has carefully analysed some samples, which were fully two years old. These show the composition to be as follows:—

Water	19.41 per cent.
Inorganic Solids	6.59 „ „
Organic Solids	73.99 „ „
The latter consisting of:—	
Proteids	65.86 „ „
Fat (ether extract)	5.14 „ „
Glycogen	.13 „ „
Sugar	.09 „ „
Extractions (by diff.) ...	2.77 „ „

The Distribution of Plants in Great Britain and Ireland.

If the plants occurring in any country are examined as to their area of distribution, it at once becomes evident that a considerable number of them are by no means equally represented everywhere in that country, but are more or less restricted to certain regions. Thus in Ireland it has been found that those plants which are not of general distribution are concentrated either on the central plain or around the edge of the island. This is probably due to the fact that the central plain is low-lying and consists largely of marshy ground, whereas the mountainous border reaches a considerable elevation and is composed largely of dry or sandy soils. It is probably a well-known fact that this central plain is formed by one mass of limestone, which was formed ages ago at a time approximately coincident with the origin of our coalfields; but the dissolving action of the surface water is so great that the soil on large portions of this limestone plain contains no chalk at all. Hence it is not surprising to find that those plants which prefer a chalky substratum, in general avoid the centre of Ireland and frequent portions of the mountainous edge, which offer a surface of bare limestone (*e.g.*, Limerick). Only a small portion of the margin of the island is calcareous; in other parts other rocks occur, and thus it is that the north, south, east, and west coasts vary considerably in the nature of their flora.

The plants which occur generally distributed throughout Ireland are mostly such as are also of widespread occurrence in Britain. Those, however, which are of central or marginal distribution in the former island, are not similarly located with regard to Britain. Here no such arrangement is possible; it is found on the other hand that some plants occur only in England, whilst others are restricted to Scotland. Further, that the plants of the east coast are markedly different from those of the west coast. The former are termed Germanic, whilst the latter are termed Atlantic plants. The Atlantic plants occur commonly in Ireland, whilst the Germanic are rare. This is probably due to the fact that the land-connection between Britain and Ireland, over which the plants immigrated from the former to the latter, broke down before Britain itself became separated from the Continent. The chief influx of Germanic plants from the Continent into Britain may thus have taken place after Ireland had become a separate island.

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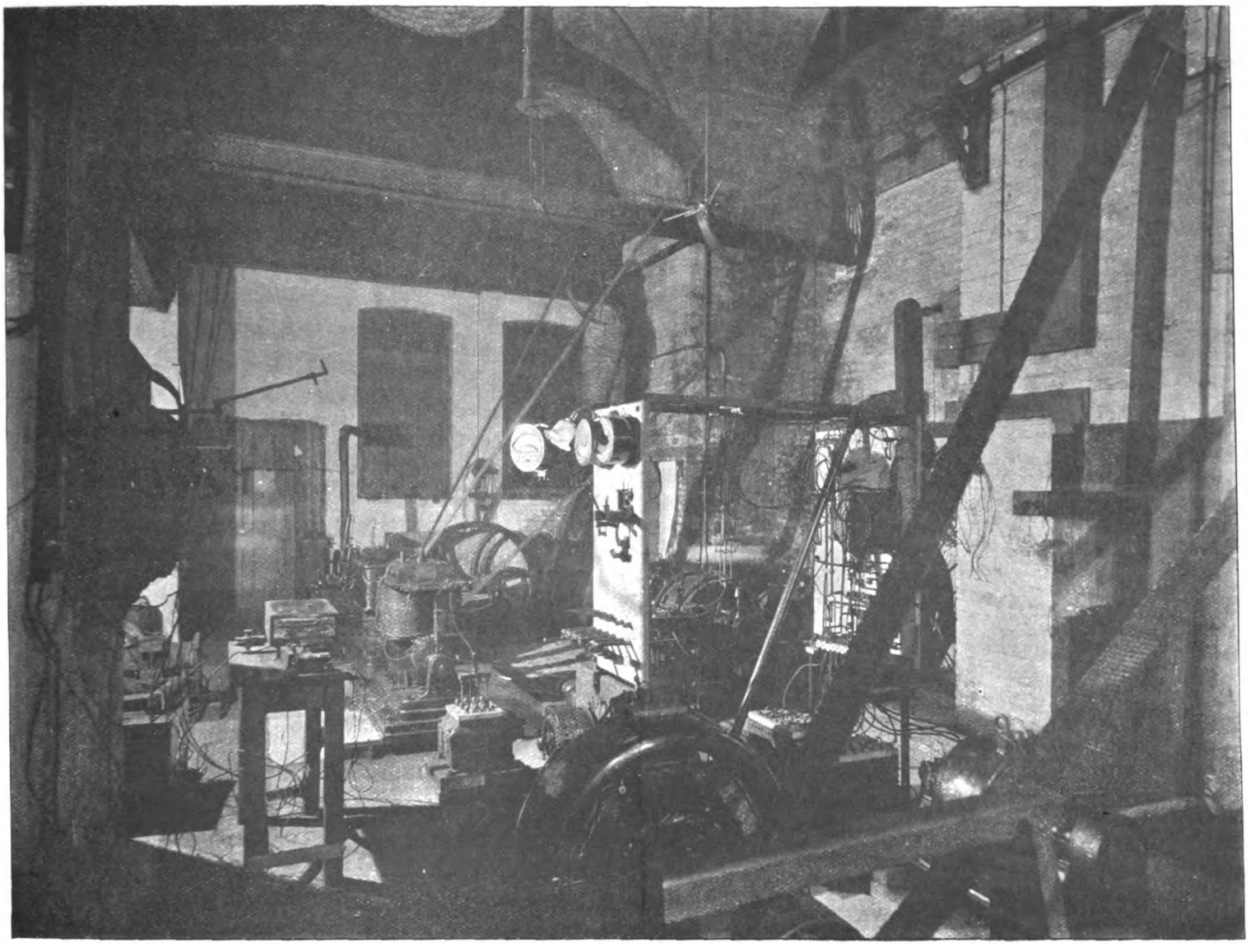
Higher Education and Research.

II. King's College, London.

A particular interest attaches to the scientific work which is done at King's College, London, because the necessity for development of that work, which the enlarging boundaries of science have thrust upon the College, has made itself felt by very striking and unmistakable signs. These signs have been the entire inadequacy of the College's income to continue the work of teaching, which for many years it had carried on with such high distinction to itself and its pupils. Twenty years ago the income of the College was enough to meet the requirements of the faculties of Art and Letters which it was first constituted to teach. It had then a distinguished place and history among teaching colleges. Its Chair of Modern History has been held by J. S. Brewer, C. H. Pearson, and S. R. Gardiner; its Chair of Classical Literature by J. G. Lonsdale, Joseph Mayor, and G. C. Warr; that of Economics by Nassau Senior, by Thorold Rogers, by Edgeworth and Cunningham. But history and economics, like theology and languages, can be taught without apparatus, so that the fees of its students were sufficient to enable the College to pay its way. In the last twenty years a great change has come over advanced teaching. The advanced student is now a student of science; and science cannot be taught without apparatus. It cannot be taught in lecture theatres, where the professor handles his set of apparatus and the students listen. It must be taught in laboratories, where the student handles the apparatus for himself; and where, in this respect, each pupil must be temporarily his own professor. Every great teaching University in the United States, in Canada, in Germany, and even in the provincial towns of this much-abused United Kingdom, recognises this great need. Everywhere the need for the multiplication of apparatus exists. In the McGill University, in Canada, every student can reproduce the demonstrations of his professor on apparatus of his own. In the Engineering College to be equipped at Birmingham £300,000 is to be spent on machinery, which the student can handle, and from which he can learn by practice what he is taught in theory.



King's College, London—The Electrical Engineering Laboratory, with Dynamos, Transformers, &c.

Electrical Engineering.

Let us take the case of electrical engineering as a capital example. In the first place the equipment of an electrical engineering laboratory is very costly. In the second place there is a considerable cost in wear and tear. And in the third place there is no science in which machinery and equipment so rapidly become obsolete as in the science of electro-technology. It is too often made a subject of reproach against electrical engineering colleges that "they do but teach backward-shop practice." The only way to remove that reproach is by continually renewing the laboratory's equipment of machinery, and by adding to it the latest types. Thanks to the generosity of Lady Siemens, the College has the splendid laboratory and accessory rooms equipped in memory of the late Sir William Siemens, as well as a set of rooms for dynamos and other machinery; and valuable gifts of machinery have been received from the Westinghouse Company and other sources. But had it not been for this last-named gift the laboratory would still have been teaching that "backward-shop practice" which is the reproach sometimes brought by practical engineering firms against the work of engineering colleges. The reason is evident. There is no industrial science so progressive as that of electrical engineering. Machines are in common use to-day which were mere ideas a few years ago; electrical machinery will be in common use ten years hence that is not dreamt of to-day. Here, for instance, is the list of equipment which Professor Wilson, the professor of electrical engineering, has drawn up as his irreducible minimum of requirement: steam boiler, direct coupled steam engine and electric generator, direct coupled gas engine and electric generator, storage battery, direct and alternate current motors, transformers. switchboards, resistance frames, measuring instruments, switches, synchronising apparatus, shafting, repairing apparatus, traction apparatus, balancers, and boosters. More room is wanted in the laboratory for at present the Professor can hardly see his class for the dynamos and belting. But the prime need is the power of purchasing new machinery—machinery not to be bought at once necessarily, but bought over a term of years, as the discoveries and inventions of electrical engineering make it necessary. The mechanical engineering laboratory is scarcely less in need of development than that of electrical engineering, but there is this important distinction between the needs of the two, that whereas in mechanical engineering the same machinery will do for demonstration purposes ten years hence as to-day, in electrical engineering it will not.

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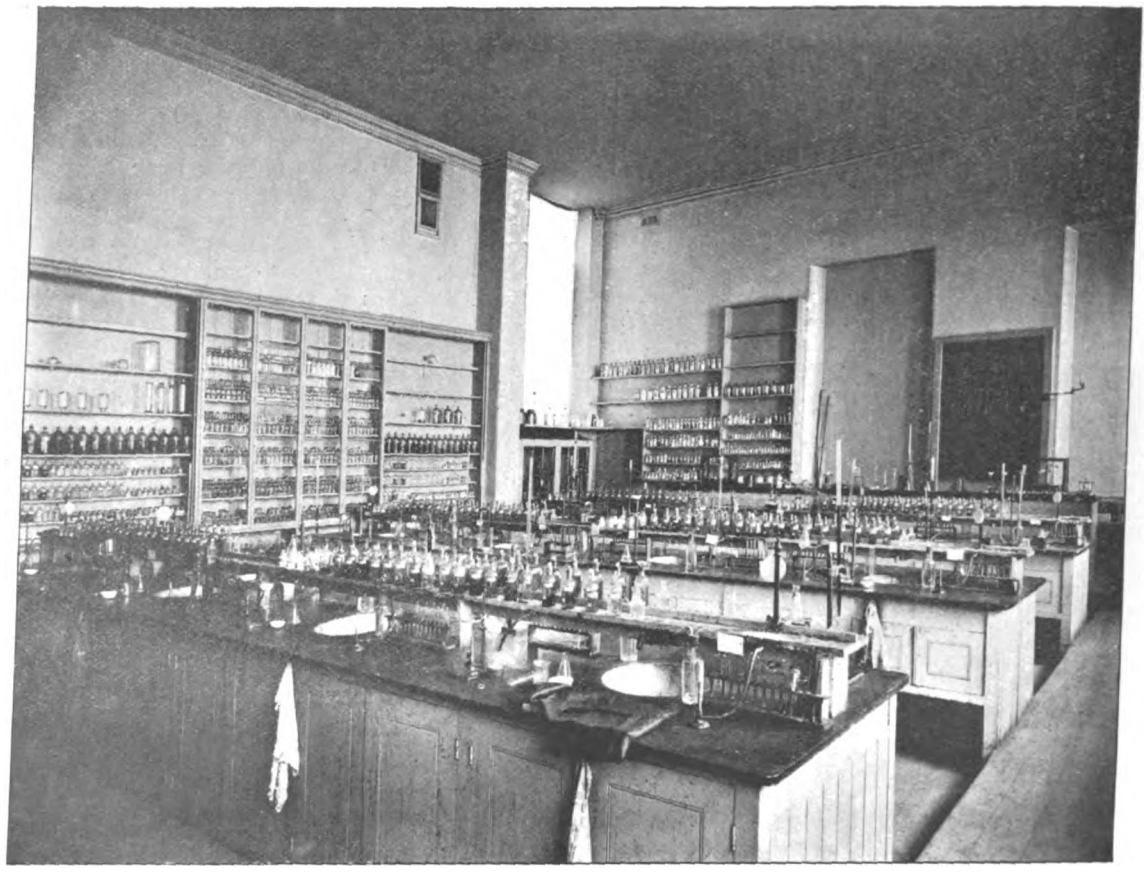
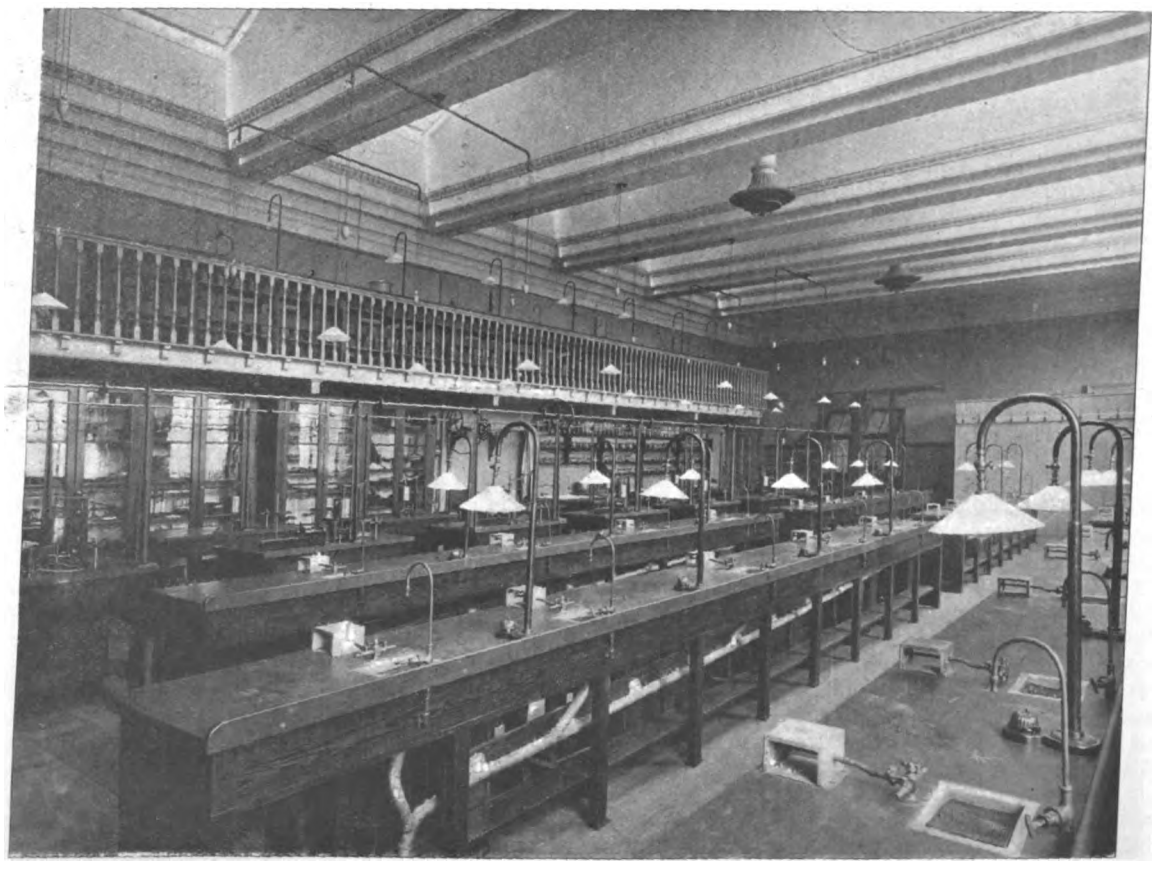
BACTERIOLOGY.

The work of King's College in bacteriology is well known. The laboratories for this subject are equipped with bacteriological, photographic and chemical apparatus, and with pathological material, and with all the fittings, instruments, and accommodation necessary for the investigation of the chemistry and micro-pathology of the communicable diseases of man and the lower animals. Each student is accommodated in a separate section of the laboratory, fitted with cupboards, gas, water, and sink, where he can work independently and undisturbed, and special arrangements are made for the convenience of medical men in practice, medical officers of health, and veterinary surgeons in practice. About 1,500 students have worked in this laboratory, mostly qualified medical practitioners, and many holding important and responsible positions in the Colonial, Naval, Indian, and Army Medical Services. The list of registered names include those of medical and scientific men from Egypt, West Coast Africa, Uganda, the Cape, British Guiana, Jamaica, Trinidad, Straits Settlements, India, Ceylon, China, Japan, Fiji, Queensland, New South Wales, Canada, Chili, Buenos Ayres, and a great many from the United States of America. Several have been especially trained with a view to investigating plague, cholera, yellow fever, madura and other tropical diseases, as well as the diseases of farm stock which are prevalent in our Colonies and in foreign countries. The high place which King's College has won for itself in bacteriological research was



King's College, London—A Chemical Laboratory.



King's College, London—The Physiological Laboratory.

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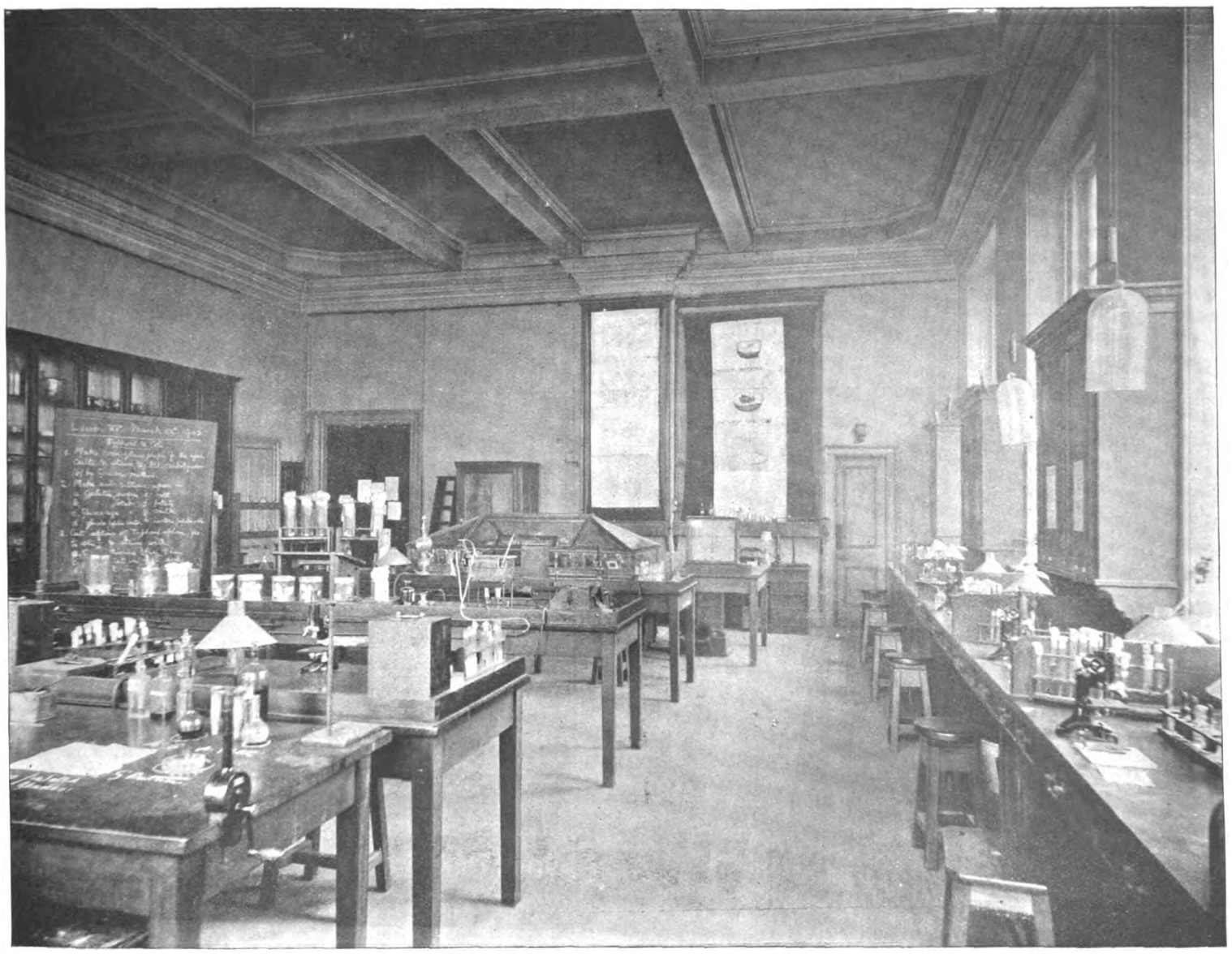
acknowledged by the recognition given to it by the Colonial Secretary. Mr. Chamberlain intimated to the Council that in the selection of candidates for the Colonial medical services preference will be given to qualified medical men who have taken their bacteriological course at King's College. Lectures are given and students prepared for the diploma in public health; and the laboratory is famous for original research. Seven original papers came from this department last year, including researches on the temperatures fatal to the tubercle bacillus; on a bacillus of acute rheumatism; on sources of diphtheria infection; and on the bacteriology of choleras.

Chemistry.

In the department of chemistry there are several laboratories for research work and for the teaching of the more specialised branches of the science. These laboratories offer especial opportunities to the students entering for the Daniell scholarship. On the part of the staff of the laboratories much special work is being done, notably that of Professor Jackson in relation to the study of phosphorescence. Researches are also carried on in the cause of decay of stonework, in the study of fermentation, the chemistry of the assimulation of carbon in plants, and special attention is given to the chemistry of industrial processes. There is a large and finely-equipped laboratory for fifty students, who are instructed in the chemistry of engineering, and chemistry for the medical examinations.



King's College, London—The Bacteriological Laboratory.

A Scientific Educational Basis.

That which has been said of the bacteriological and engineering laboratories, applies more or less to every branch of scientific teaching in the College. It has been in the van in its scientific education for the last twenty years. The truth of this is proved alike by its bacteriological research, its electrical laboratories with their induction motors and polyphase machinery, as well as by the sixty papers in original research produced last year by its faculty of science. Much is due to the devotion and self-abnegation of its professors, the remuneration for whose services is lamentably disproportioned to their distinguished attainments and educational capacity; occasionally, as, for instance, in the case of Professor Crookshank, to whom the bacteriological laboratory is very greatly indebted, they have increased the efficiency of the laboratories at their own expense. But notwithstanding generous donations, the expense of scientific apparatus is so heavy that the College remains hampered by the cost of putting its education on a scientific basis. If its admirable work is to be satisfactorily carried on, not only is it necessary that its debts should be paid off, but additional funds must be provided for increased laboratory space, and further equipment, and no less important, for the endowment of professorial chairs with salaries less disproportionate to the attainments of its staff. Additional expenditure has, moreover, been forced upon the College by the increase in the numbers of its scientific students, an increase which has more than balanced a falling-off in the numbers of its Art students, who represent a far less expensive educational department. Besides this general increase in its numbers the College, which is now an integral part of London University, will have to strain all its resources to attain to the level of the University standard, while hitherto many of its classes have been studying merely in order to obtain the College's own diploma. Obviously, then, the need of the College should appeal strongly to Londoners, whose own interests require that it should be securely established on the scientific basis that it has itself so strenuously attempted to form. In Manchester, Liverpool, Leeds, and Birmingham, the citizens take a pride in the admirable work of their colleges, which largely accounts for their excellence. In the United States and Canada like institutions have found support from the generous donations of millionaires, such as Lord Strathcona, Mr. Carnegie, Mr. Rockefeller, and Mr. McGill. Only by such means as these, a healthy municipal spirit, and generous donations can great educational institutional institutions of London be maintained in their efficiency, an efficiency on which depends that secondary education essential to Great Britain's continued existence as an industrial nation.

In conclusion it must not be assumed that the brief indication given above of the College's equipment is by any means complete. It provides at present for the teaching of physics and natural philosophy; it has a fine laboratory and other rooms for geology, a new laboratory for botany, new physiological laboratories, a laboratory for pharmacology, public health laboratories, small laboratories for teaching and research in pathology and neuro-pathology, engineering and applied mechanics, and departments for architecture and metallurgy.

E. S. G.

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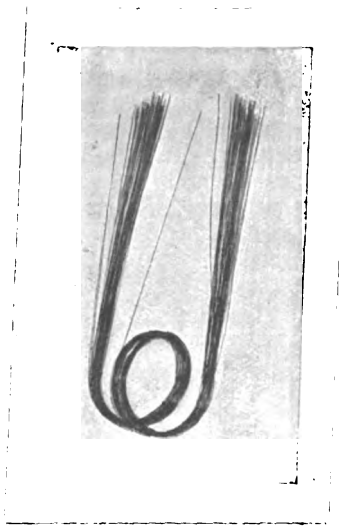
Making a Glow Lamp.

THE little glow lamps which are as familiar now to everyone as gas burners, and which in a few more years may be even more numerous, are, in form, of apparent simplicity. They consist, to a casual observateur, of merely a glass bulb, a carbon filament, and a brass cap. When



Cellulose Filaments.

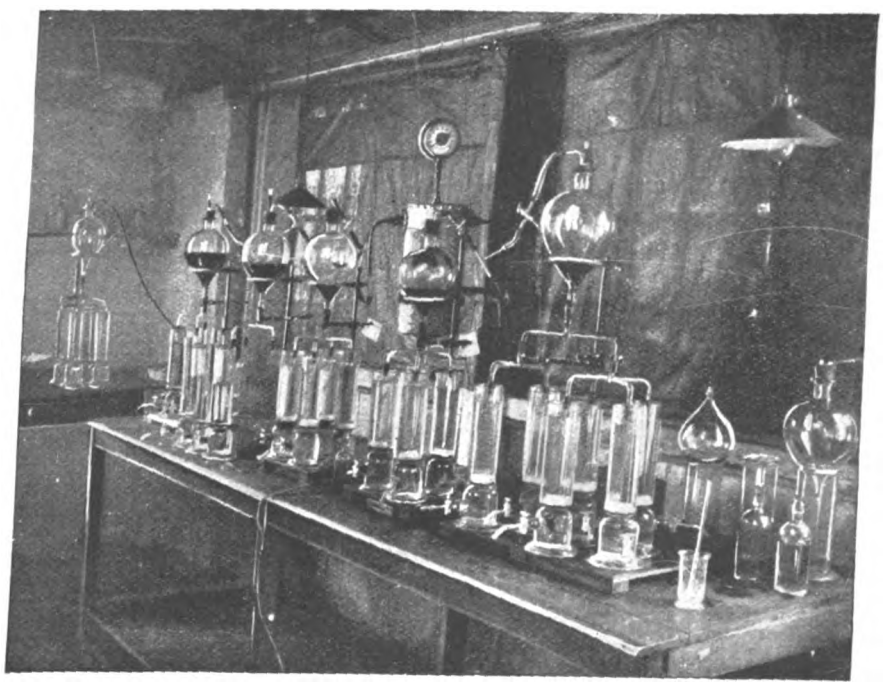
it is remembered, however, that a lamp has to pass through as many as twenty-six distinct operations before the glass tube from which it originates is transformed into a bulb fitted with filament and terminals, it will be admitted that its manufacture requires very considerable skill and experience. So little has been written heretofore concerning the actual processes involved in glow lamp manufacture, that the following brief account of a visit which we recently paid to the works of the Sir Hiram Maxim Electrical and Engineering Company, Limited, will doubtless be read with interest.

THE FILAMENTS.

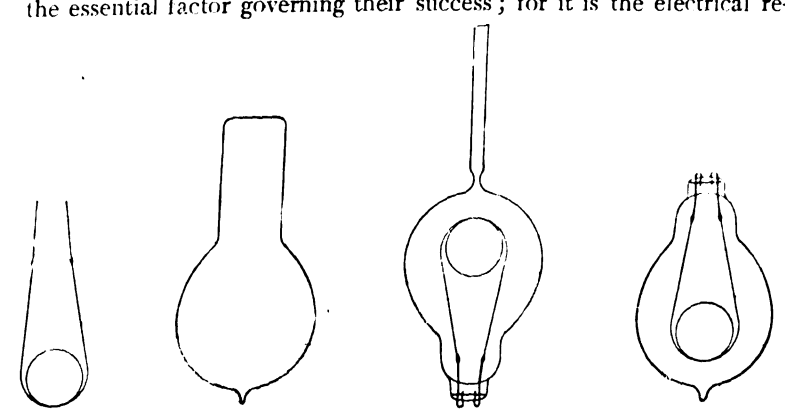
The composition of the filament used in glow lamps is, of course, the essential factor governing their success; for it is the electrical resistance of this filament which, by giving rise to incandescence, furnishes the radiation, or light. The filament employed in the "Maxim" Lamp is made from cellulose, obtained from Japanese paper and other materials by a secret process, by means of which a large quantity of filament can be manufactured exactly homogeneous throughout. The cellulose solution is placed in inverted glass flasks, as shown in Fig. 1, from which it is forced under air pressure through tubes provided with jets, into tall glass jars containing a setting fluid. The jets are sapphires pierced with holes of varying size according to the diameter of the filament required. The cellulose as it issues from the jets in a continuous thread, passes through the alcoholic setting fluid, and is thereby solidified and hardened. The thread forms into an even coil at the bottom of the jars and is then taken out and treated in chemical solutions. The specific gravity and the proportions of the materials forming the cellulose have to be kept very exact, and the temperature regulated within fine limits if the best results are to be obtained; while the pressure of the air used to force the solution from the flasks into the setting fluid must be regulated with accuracy according to the diameter of the jets employed. As thread it is carefully washed, dried, and its diameter carefully measured and brought to pattern. It is a tough flexible thread, looking rather like catgut. The second stage of its career is that of winding it in lengths on carbon blocks to fit its required shape. It is then incinerated in graphite crucibles, and at the end of its severe baking the cellulose thread has become carbon—carbonised cellulose.

JOINING THE PLATINUM CONNECTIONS.

There follows a delicate piece of manipulation. The carbon filament has, we know, to be joined to the wires of an electric circuit. This connection has to be made through platinum. The shiny elastic carbon filaments are therefore attached to short lengths of platinum wire, which serve as conductors between the outside terminals of the lamp and the ends of the filament. Platinum is the only material which up to the present has been found to possess all the necessary properties for this purpose, for it has the same co-efficient of expansion as that of glass, and will stand the intense heat of the blow-pipe without deterioration. As platinum is worth between £4 and £5 an ounce, great care is taken not to waste it—either in cutting it to the exact length or in attaching it. The delicate and ingenious operation, which is rather too complicated to be described here, is carried out wholly by girls and young women. When the filaments are joined to their platinum wires, the now complete filament is taken to the "flashing" department. The object of "flashing" is twofold. It strengthens the carbon filament, and gives to it the correct electrical resistance for the current which is to be sent through it. The filament to be treated is connected with an electric supply, and placed in a glass receiver connected with a system of special vacuum pumps. This receiver is coloured, so that no harm may be done to the eyes of the operator. A few drops of a fluid hydro-carbon are sprinkled by means of a brush into the receiver, which is then closed, and the air pumped out, so that nothing is left inside but hydro-carbon vapour. A strong current is now directed through the filament, which becomes vividly incandescent, and in this state sucks up, attaches to itself, the hydro-carbon vapour. The vapour deposits itself on the filament in the form of an exceedingly hard outer crust of carbon. The filament is now complete, and is sealed in the glass bulb prepared for it. A tiny portion of the platinum connection is allowed to project outside the cement sealing with which the filament is stoppered into the bulb.



The Cellulose Squirting Room.



Filament. **The Bulb—First stage.** **The Bulb with Filament inserted.** **The Bulb exhausted.**

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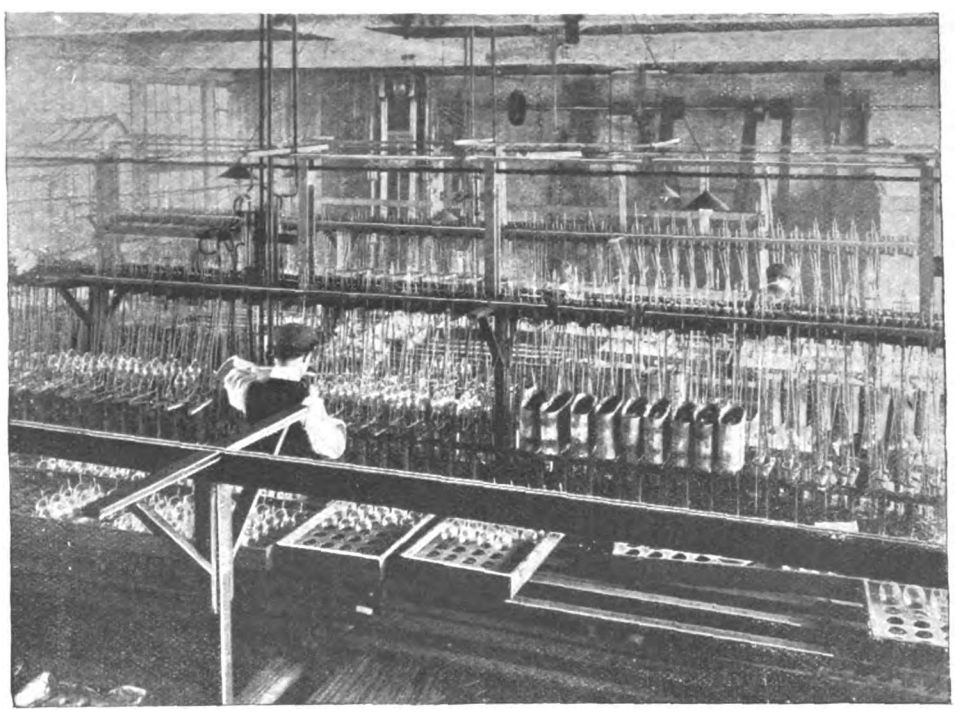
The Bulbs.

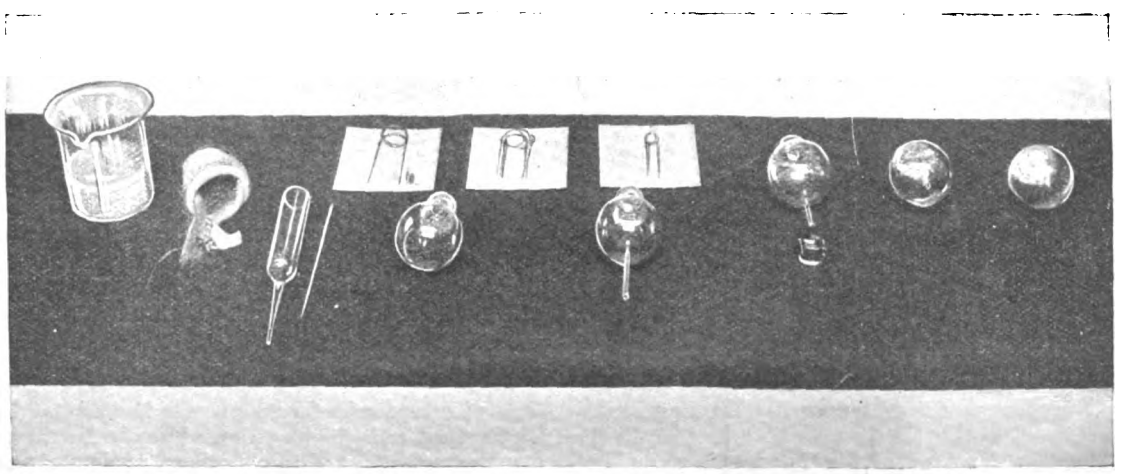
The blowing of the bulbs is, of course, a special process requiring deftness and skill; and when the filament stem is secured in them they are allowed to cool slowly on a circular annealer. There remains one more "principal" process. Nearly all those steps described embrace minor processes, which the narrative omits for the sake of clearness. The last process is that of exhausting the air from the bulb. At the bottom of a glow lamp bulb one sees a little glass spike. In the penultimate stage of the glow lamp's manufacture the spike was a tube leading out of the bulb. Through it the air is drawn out and the bulb exhausted. When the air has gone the glass tube is annealed and becomes a spike, while the bulb itself remains a vacuum. The tubes of the bulbs are in the exhausting process sealed in groups of six on to a glass tube connected with the air pumps. Powerful mechanical oil pumps are first made use of to exhaust as much of the air from the bulbs as possible in a short space of time, and Sprengel mercury pumps complete the process of exhaustion. The process is aided by heating the glass bulbs, so to expand the air and to drive off residual vapours. An electric current is also finally sent through the filaments, thereby heating them to a high incandescence, and driving off the occluded filaments and connections. When the exhaustion is completed the amount of air left is far less than the millionth of the pressure of the atmosphere. The tubes are now carefully melted and sealed; and the only remaining processes are those of capping, engraving, and testing by photometry for candle power. These processes, though not less delicate and not less interesting than those of making the lamp, may be regarded as part of the equipping of a glow lamp rather than of its making. These processes which we have described are complicated by other expedients that have been omitted for the sake of clearness. Some idea of their number and complexity may be gained from the last of our photographs, which shows, in as small a space as possible, the numerous stages through which an incandescent electric lamp passes during its manufacture. On the extreme left will be seen a beaker containing some cellulose solution. The next object is a coil of "squirted" filament, while on the three cards behind can be seen respectively the filament after carbonisation, the same fitted with its platinum wires, and lastly, mounted on its glass stem. The objects in front are—starting from the left—the glass tube before blowing; the small glass tube ready for attaching to the bulb when blown; the bulb; the bulb with tube attached; the bulb with filament sealed in; the lamp after exhaustion; and, finally, the completed lamp with its brass cap. For the explanation of these processes we are indebted to Mr. A. W. Hill, the manager of the Gillingham Street works, and to Mr. Howard Wright, the chief engineer of the company.



Exhausting the Air from the Bulbs.

Man-Lifting Kites.

Since Major Baden-Powell, in 1894, demonstrated the possibility of raising a man to a considerable height in the air by means of kites, both he and other inventors have made numerous ascents. In Australia, America, and Russia, successful experiments have been made, and now Mr. F. S. Cody has been making demonstrations in various parts of England. At Woolwich, on March the 13th, he made some very satisfactory ascents to a height of about 200 feet (although on previous occasions he is said to have been lifted as high as 1,200 feet). The kites, as may be seen from the photographs here reproduced, are of rather novel design, being of the well-known Hargrave or "Box" type, with wings spread out on each side. Two or three kites are first sent up on a long wire rope, and then a much larger kite is fixed to a pulley, which is drawn up the rope with a basket, in which the man sits, suspended from it. By means of a lever the pulley can be jammed at any desired point by the aeronaut, and by means of a rope fastened to the front of the kite the latter can be so tilted as to cause it to descend down the rope.



Photograph showing the various stages of making a Glow Lamp.

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Botanical Notes.

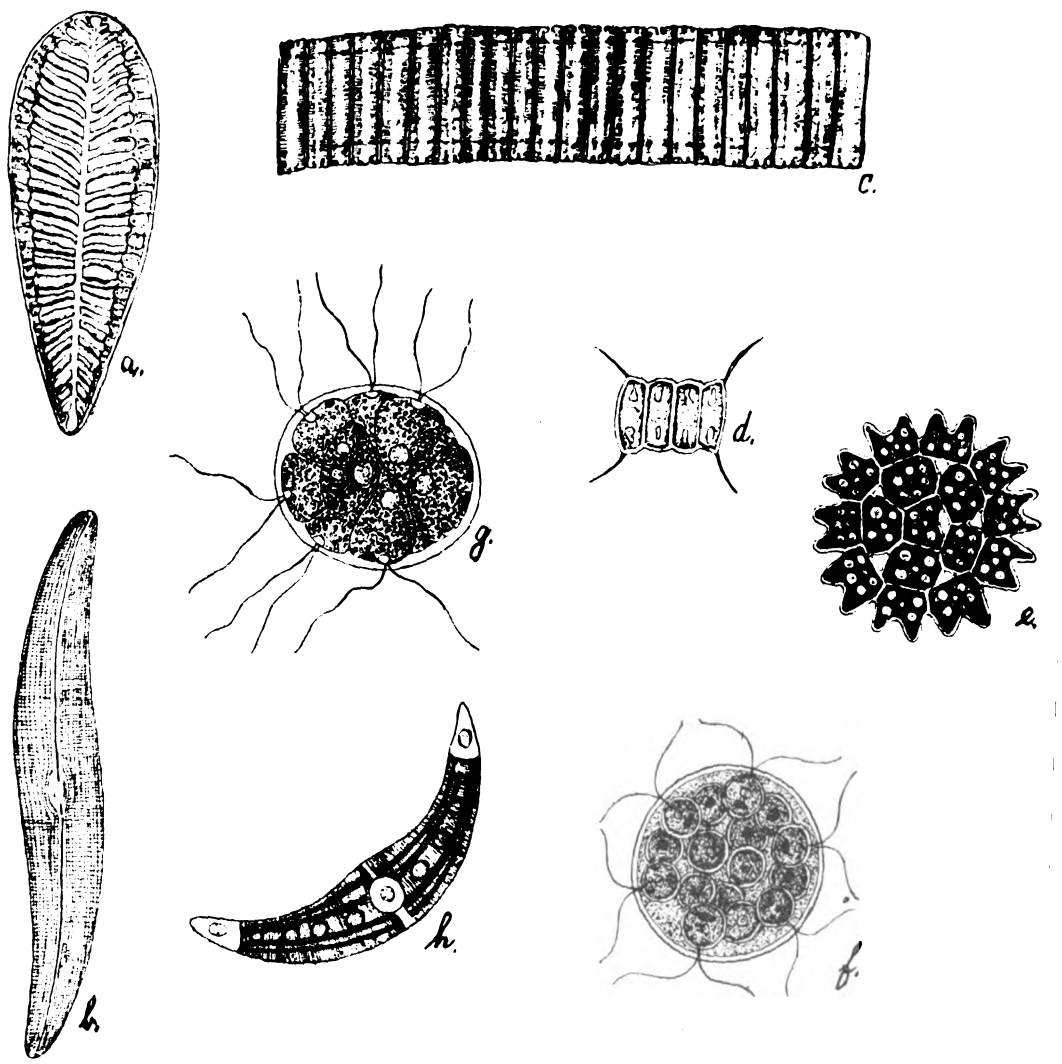
By F. E. Fritsch, B.Sc., Ph.D., F.L.S.

The Phytoplankton of the River Thames.

Very few of the large multitude of pleasure-seekers, who spend their summer days on the river are probably aware that myriads of little organisms of diverse shapes throng the upper layers of the flowing water. Yet if a net of fine gauze be drawn through the water for a few minutes, a layer of what looks like finely-divided mud will be found to have collected on its sides; and a microscopic examination of this deposit at once reveals the world of micro-organisms, of which it is composed. This organic life, which is to be found at the surface of every piece of water, is known collectively as Plankton, and in rivers it is mainly composed of minute plants, animals being very much in the minority.

The Plankton of the Thames (and of rivers generally) is further characterised by the prevalence of a certain group of minute unicellular plants, in which the living body is surrounded by a coating of silica, whose surface is sculptured in the most varied manner. The living portion of these minute Diatoms, as they are called, contains a brown pigment, and hence the muddy appearance of the river Plankton. The figures (Figs. *a*, *b*, and *c*), will give an idea of the variety of form assumed by these little organisms. Intermingled with these Diatoms we find a few representatives of the Green Algæ, chiefly the little 4-8-celled *Scenedesmus* (Fig. *d*), and the *Pediastrums*, consisting of a flat plate of cells, the most external of which are drawn out in a characteristic way (Fig. *e*). Further, *Eudorina* and *Pandorina* are frequently to be found moving along rapidly, the former a hollow sphere of 32 cells (Fig. *f*), the latter a solid group of 16 (Fig. *g*); in both, two delicate threads or cilia extend from each cell into the water, and by their rapid motion cause the movement of the entire colony. Finally, a little half-moon-shaped Desmid is commonly to be met with (Fig. *h*). The abundance of Diatoms is characteristic of the Plankton of rivers; in that of stagnant water the reverse is the case, the green forms (as also the animals) excelling in numbers, and as a consequence such Plankton usually has a greenish colour.

A large proportion of the Plankton of the Thames is probably derived from the slow-flowing tributaries and the backwaters higher up the river. These act as reservoirs, from which new supplies are constantly issued. Many of the little Plankton-organisms are unable to reproduce in swiftly-flowing water, so that in a stream like the Danube at Vienna the entire life has emanated from the upper, quieter portions of its course. In the Thames, however, whose current is not nearly so strong, many of the species present are able to increase their numbers even in mid-stream. Carried onwards by the flow of the river, each individual gradually approaches nearer and nearer the estuary, and here the increasing brackishness of the water begins to exert a fatal influence on the Plankton. At Kew, already, where the percentage of salt in the water is considerably greater than in the upper portion of the stream, we find that a large number of the delicate green forms are destroyed, whilst even the more hardy Diatoms have sensibly decreased in number. But here also we observe a new element appearing; truly marine species of Diatoms are carried up by the tide, and such forms may even be found in the river at Kew, whilst lower down they constitute a very important part of the Plankton.



Plankton of the Thames.

The Revival of Life on Krakatoa.

Probably most readers have heard of the terrible eruption of the volcano of Krakatoa, situated in the Straits of Sunda, in August, 1883. The disturbance was so great that traces of it were perceptible at points many thousands of miles away from the scene of the catastrophe and the minute volcanic particles were carried by the currents of the air for distances hitherto unrecorded in the transference of atmospheric dust. The island itself presented a scene of the utmost desolation after the eruption, all traces of organic life having disappeared.

Three years after the catastrophe, the island was visited by Treub, who gives an interesting account of the commencement of a new flora on the desert formed by the volcano's activity. The first forms of plant-life to appear were minute, gelatinous blue-green Algæ, whose minute spores had been carried there by the wind; six species were observed. This blackish-green mucilaginous layer, which covered a large part of the rocky surface of the island, offered a suitable substratum for the germination of moss and fern spores, which, in virtue of their small size, are readily carried considerable distances by the currents of the atmosphere. At the time of Treub's visit, ferns were the most important and characteristic constituents of the new flora. The phanerogamic vegetation was limited to a few littoral species, whose seeds and fruits had been brought by marine currents, and to a few representatives of forms, whose seeds are provided with a means of dispersal by the wind; these latter had chiefly established themselves inland. No plants introduced by birds or man were found.

In the spring of 1897 a further visit was paid to the island. It

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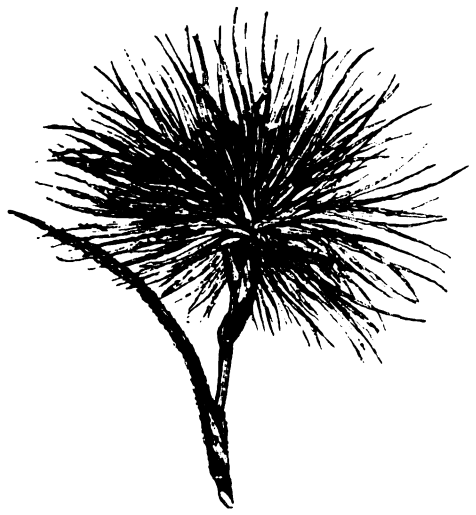
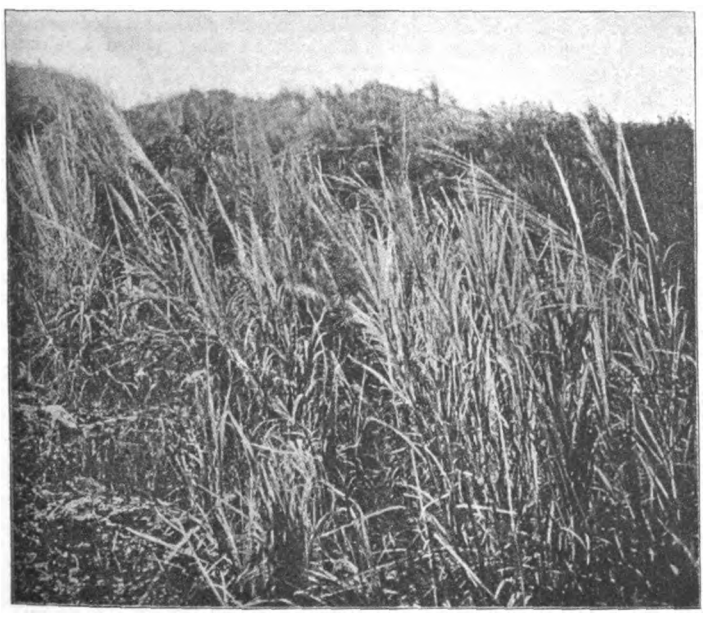
was found that the flora had progressed relatively very slowly, the number of vascular plants having only increased to 62 species, as against the 26 found on the occasion of the first visit. The shores of the island were now inhabited by a number of plants characteristic of the Malayan littoral region. The most important of these is a species which has elongated creeping stems, extending in all directions and rooting at frequent intervals (*Ipomoea Pes capræ*). In fact this plant is so characteristic of this type of littoral vegetation, that the latter has been designated the "Pes-Capræ" type, after its most important constituent. Certain curious grasses occur abundantly in the litoral flora, notably *Spinifex squarrosus*, whose mode of propagation is very interesting. A former writer tells us about this



Spinifex Hirsutus—showing the head which drops off when the seeds are ripe and which is carried along the sands by the wind.

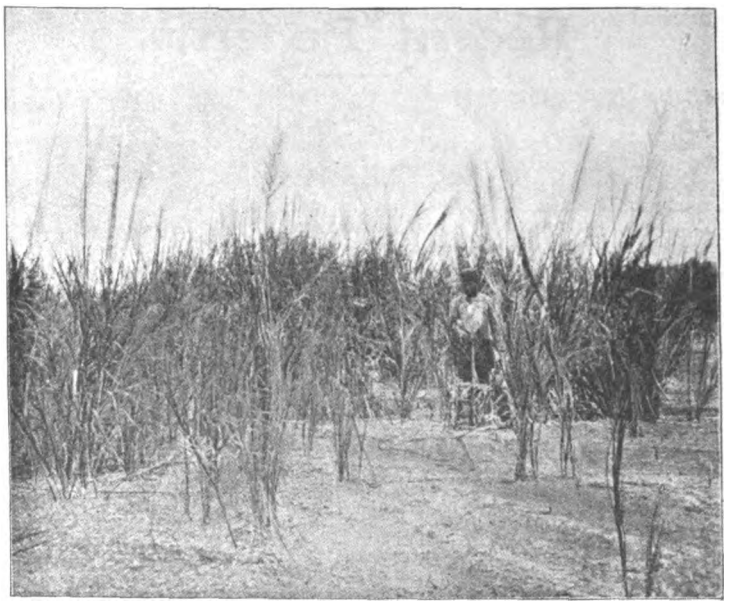
grass, that "when the seeds are mature and ready for dispersion, the heads become detached from the plant and are carried by the wind with great velocity along the sands, over the surface of which they are impelled on their elastic spines. One of these balls may be followed by the eye for miles, as it hurries along the level shore, dropping its seeds as it rolls, which speedily germinate and strike root where they fall." The heads are so light that they readily swim about on the water, and having once established a footing they spread very rapidly in the manner just described. Screw-pines (*Pandanus*) and tropical species of spurge (*Euphorbia pilulifera*) are further constituents of the flora established on the coast of Krakatoa. It is interesting that up to 1897 no mangroves had obtained a footing on



Vegetation in the interior of the Island of Krakatoa.

the shores of the island. A large number of seeds and fruits, belonging to a variety of plants, were found washed up on the shores by the waves and many of them had already developed into seedlings.

Further to the interior of the island the flora is represented by a kind of grass-steppe (Savannah), due to the presence of giant-grasses, considerably exceeding a man's height. Most important are a species of sugar-cane (*Saccharum spontaneum*), and of reed (*Phragmites Roxburghii*), whilst numerous climbing plants occur in the dense growth of grass, rendering a passage difficult. On the ridges the grasses are of smaller size, and numerous ferns, together with a few flowering plants occur amongst them, whilst the steeper slopes are inhabited by ferns alone, as was the case ten years previously. It is



Grass on the Shore of Krakatoa.

noteworthy that bushes are rare and trees practically absent. It will probably take some time before the superficial strata of the island are decomposed to a sufficient depth and enough humus has been formed for the reconstitution of the forest which flourished there before the great eruption.

Heat Radiated by the Moon.

The partial eclipse of the moon on the 11th and 12th of this month (the first contact being at 10.34 p.m. on the 11th, and the last contact at 1.52 a.m. on the 12th) may be an opportunity for testing the amount of heat radiated by our satellite. Attempts have frequently been made to ascertain whether the moon possesses any inherent warmth, or whether the very minute heating effects are due solely to reflected sun-heat. Prof. Piazzi Smyth, recognising that the small caloric effects might be absorbed in the upper regions of our atmosphere, made an interesting experiment many years ago at a height of 4,000 feet, on Teneriffe, from which a ready idea can be gathered of the heat given out. He found that a candle placed at a distance of 15 feet from his instrument gave three times as much heat as that radiated from the full moon. It has been proved by observation during eclipses that the moon radiates heat from its surface in addition to that reflected from the sun. Prof. Langley made some very exact measurements of the lunar "heat spectrum" under such circumstances, which extraordinary observations showed that the thermal energy given out only amounted to one-thousandth of a degree centrigrade. But it is supposed that this small amount of heat is probably only due to the solar heat which has been absorbed.

Steel Alloys for Permanent Magnets.

A subject not well understood is that of the connection between hard steel and magnetism. We know that steel is readily capable of being permanently magnetised, and we know that soft iron very rapidly loses such properties. Experiments have recently been made in France on different alloys of iron with manganese, nickel, chromium, and other metals, to ascertain their magnetic properties. An alloy of 7.80 per cent. of manganese and .46 of carbon was heated to 750° and allowed to cool slowly. This was found to possess the hardness and other characteristics of steel, except that it was incapable of permanent magnetisation. It was then plunged into liquid air and its temperature thus reduced to a very low point, which resulted in its attaining in a high degree the property of permanent magnetism. An alloy containing 25 per cent. of nickel allowed to cool from a molten state is not magnetic, and is unaffected by a magnet brought in contact with it. After being subjected to the low temperature of liquid air, however, it becomes strongly magnetic.

COHERERS.

To The Editor "Illustrated Scientific News."

Dear Sir,

I was exceeding interested in the article on Coherers in your last issue, and thinking it might interest your readers I send particulars of a simple experiment of a similar character but requiring no other apparatus than a telephone set.

If the apparatus is in good working order put the transmitter on short circuit; then hold the ear piece of the receiver to the mouthpiece of the transmitter. The result is similar to that described in experiment two; the receiver will give out a continuous note very much resembling a whistle.

Yours truly,

W. CASSELS BROWN.

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Recent Patents.

24,118. Indicating Trajectories of Projectiles. SLAZENGER, R., 9, Kensington Court, London, W. Nov. 27.

To indicate the course of a bullet so as to enable a marksman to correct his aim, the bullet is coated with a paste of fine gunpowder and gum, which is fired by a second coat of some friction powder, or by a detonator, on the discharge of a firearm. The friction powder may consist of a mixture of amorphous phosphorus, carbonate of potash, manganese peroxide, magnesium powder, potassium chlorate, and potassium nitrate.

23,551. Photography. SOC. ANON. DES PRODUITS PHOTOGRAPHIQUES M-Y., 3, Rue Brantôme, Asnières (Seine), France. Nov. 20. *Patent not yet due for Sealing.*

Sensitized Films.—Relates to sensitized films capable of being stripped from their supports. The paper or like support is first coated with a layer of gum or resin, a solution of dammar gum in benzene being mentioned as suitable. The gelatine film contains a certain amount of glycerine or the like, which is washed out in processes of developing, fixing, &c. The film thereupon detaches itself from its support. The sensitive coating is applied to the gelatine film. Starch, sulphate of baryta, or the like is added to the gelatine film or to the sensitized coating for the purpose of removing irregularities. To prevent the reproduction of the grain of the paper, it may be coated with gum lac, or a coating of sulphate of baryta and alumed gelatine glazed by calendering may be applied.

24,619. Photography. NEWTON, H. E., 6, Breams Buildings, Chancery Lane, London.—(*Farbenfabriken vorm. F. Bayer and Co.; Elberfield, Germany.* Dec. 3.

Developing; fixing.—Relates to the use of ketone-bisulphites in developing and fixing baths to prevent oxidation. An example of a developing-bath is the following:—1 part of pyrogallol, 1 part of acetone-bisulphite, 6 parts of potassium carbonate, and 100 parts of water.

23,284. Explosives. FIEDLER, M., House Schelaputin, Mochowaja Street, Moscow, Russia. Nov. 18.

Relates to a safety explosive formed from a dry mixture and a liquid, the two being kept apart until required for use. The dry mixture consists of 70 parts of potassium chlorate and 20 parts of potassium permanganate. The liquid consists of 9 parts of turpentine and one part of carbolic acid.

24,524. Alloys. BILLINGTON, C., and NEWTON, J. [*trading as* Billington and Newton], Vulcan Works, and BILLINGTON, C., "Studleigh," Porthill, both in Longport, Stoke-on-Trent. Dec. 3.

Alloys capable of being hot-rolled or squirted for making sheets, wire, rods, tubes, &c. The alloy consists of about 60-80 per cent. of copper and 40-20 per cent. of zinc, to which is added ½-4 per cent. of silicon. When the metal is to be exposed to sea water, about 1 per cent. of tin is also added.

Prize Competition.

Once again we have a most difficult task put before us in the judging of the many solutions (which have nearly doubled since last time). Several intricate questions have been put before us, and so great are the difficulties becoming that we fear we must alter the form of the competition in some way, and with this view we are corresponding with competitors to ascertain their views. Until this matter is decided it will be best not to announce another subject.

Results of last month's Competition.

K. O. H. No. 1 (**35**). Depends on light focussed by prisms on selenium altering resistance to electric current. *Complicated, and would not alarm unless bright flame.*

Q. E. D. No. 2 (**39**). Thread dipped in solution of saltpetre run round room through staples. Easily ignites, and on burning through connects circuit of electric bell.

BROS. (**40**). Vessel suspended filled with paraffin wax, in centre of which is glass vessel with glass plate on top containing bromine. *Action not further described.*

GUNNER (**45**). Electric wire, preferably of some readily fusible alloy, runs around the buildings conveying current to electro-magnet. When fused through current stops and armature falls, giving alarm. *Continuous current would soon wear out batteries.*

W. E. KNOWLES (**45**). Metal cylinder with piston, let into wall. On air becoming heated piston is pressed outwards and makes electrical contact.

BERTRAM (**45**). In order to give the alarm on any slight increase of temperature, a self-recording thermometer shows average daily variation on non-conducting paper on metal drum. This paper is cut away just above line of maximum temperature, so that directly it gets hotter, the pointer moves on to the metal drum and completes electric circuit. *Good in principle, but not likely to do for everyday practice.*

KHARKI (**47**). Reservoir contains carbon dioxide under pressure, from which tube of fusible metal runs round house. If latter fuses, gas is evolved in reservoir and passes through siren, giving alarm.

HUMBER (**49**). Thermometer with electrical connection to bulb. Steel needle inserted in top of tube adjustable to given temperatures passing through rubber tube.

KASS No. 2 (**50**). Air-tight chamber contains sulphurous anhydride, which expands with heat and makes contact. *Not so simple as thermometer alarum.*

CANTAB No. 3 (**50**). Ordinary mercury thermometer balanced when temperature normal, but when mercury expands to certain point, end dips and forms electric contact.

A. C. T. No. 1 (**55**). A thermometer with bulb of alcohol balanced so that at a given temperature a platinum point dips into adjustable cup of mercury.

L. R. CONNOR (**56**). Glass tube sealed at bottom, and containing small quantity of mercury half-way up. Heat of fire causes air in lower part to expand and drive up mercury till it touches platinum wires closing electric circuit.

R. FENTON No. 1 (**57**). Rod of zinc rigidly fixed at one end to bed of glass, close to other end butt of metal also fixed to glass. Heat of fire expands zinc rod and forms electric connection.

R. J. M (**57**). Small glass bulb filled with mercury placed in vessel into which two electric wires enter. On heating, bulb bursts, and mercury forms connection.

THERMO (**60**). Tube and bulb similar to large thermometer, containing mercury and other suitable liquid. Wires fused in at fixed points to connect electrically and ring bell.

Q. E. F. (**60**). Thermometer with platinum wires fused in to make electrical contact at 90°.

K. O. H. No. 3 (**60**). Thermometer with platinum wires fused into bulb and into a point at fixed temperature. Mercury makes electric connection. System of bulbs at top to adjust to given temperature.

A. C. T. No. 2 (**60**). "U" shaped thermometer tube with bulb of alcohol, and column of mercury connected with wire, which on rising to given temperature connects with platinum wire.

ÆNEAS (**60**). Large mercury thermometer causes electric connection between two wires fused into tube at given height. Adjusted by piston in bulb.

CANTAB No. 1 (**61**). Thermometer with platinum wires fused in to make contact at fixed temperature.

E. M. F. (**64**). Thin rod of metal passes through ring and has ends fixed. When heated expands and bends, touching ring, which gives electrical contact.

BACILLIGRAPH (**65**). Ordinary mercurial thermometer with platinum wires inserted to connect electric bell. Protected by inserting in cylinder of wire gauze.

ALARM (**65**). Spring held apart from electrical contact by pencil of wax, which on melting releases spring. *Simple.*

LEPORELLO (**65**). Vessel has division at bottom separating two small quantities of mercury forming terminals of electric circuit. A capsule of wax containing mercury supported above. On wax melting mercury bridges division and contact made. This releases a hammer which sets off rocket. (*Mercury capsule good idea, but rocket arrangement does not appear very practicable.*)

KASS No. 5. (**68**). Small cylinder of wax or fusible alloy takes strain of spring. On wax melting spring closes electric circuit and rings bell.

CANTAB No. 2. (**69**). Brass ball connected to wire is suspended by bar of wax composition over mercury. The whole enclosed in metal sphere. On wax melting electrical contact is made.

CANTAB No. 4 (**70**). Metallic spiral of brass and steel bands firmly united unwinds on being heated owing to difference of expansion and causes electrical contact.

KASS No. 3 (**70**). A tube, with bulb containing mercury, is bent and suspended from a pivot near the bend. On the mercury rising from excessive heat it gets over the bend and runs into second bulb, thereby altering balance and causing electric contact.

KASS No. 1 (**72**). Principle depends on fact that a thread, preferably of horsehair, treated with solution of caustic soda and dried in vacuum, will lengthen when smoke comes in contact with it. Such a thread wound round pulleys holds up spring electric contact. *We must take it for granted that this is the case.*

R. FENTON No. 2 (**75**). Pipe runs round rooms hermetically sealed. Corrugated metal box connected with it expands when air heated and closes electric circuit.

E. M. F. No. 2 (**76**). Wire stretched across room. One end to bell crank on which weight hangs. When wire expands from heat, weight touches electric contact and rings bell.

FIGARO (**78**). Light steel tubing in coil, or running round room, has one end sealed and other ends in mercury reservoir from which also runs capillary tube and tube up which mercury would flow when air presses from *sudden* increase of temperature, and electrically connects with wire in tube. *Quite a good idea, but rather complicated design.*

KASS No. 4 (**80**). A compound spring preferably of zinc and platinum, which expand unequally, will tend to curl round on being heated and connects electric wires.

K. O. H. No. 2 (**80**). Two wires of fusible alloy run in grooves round rooms. If melted they run together and electric contact made.

K. O. H. No. 4 (**80**). Cup of iron has lining of paraffin wax, and is filled with mercury. Cover, similarly coated, is screwed on. An insulated wire connects with mercury and another to cup. When heated wax melts and contact made.

SLIDE RULE (**83**). Set of differential air thermometers, each consisting of a large air-bulb, at one end of a U tube filled with mercury, the other end being joined to iron pipe which runs through the building and forms common bulb to all the thermometers. Temperature of air in latter gives a mean pressure. Local rise of temperature causes air in bulb to expand and mercury to rise and complete electrical circuit in wires inserted in tube.

MEPHISTO (**84**). Two spirals, one of solid copper, the other of light copper tubing perforated, placed side by side. Latter, presenting large surface, expands more rapidly than former, and on sudden increase of temperature presses lever attached to solid spiral and completes electric circuit. *Quite good, if slightly complicated in design.*

VANDERDECKEN (**85**). A long tube (spiral) of glass contains mercury. At upper end diverted in two. One branch a capillary tube terminating in reservoir, other branch rises higher, and has two electric wires inserted. If sudden increase of temperature, mercury unable to flow quickly through capillary rises in other and completes circuit. Needle valve operated by magnet regulates flow in capillary.

The Monthly Prize of One Guinea has therefore been awarded and sent to

"VANDERDECKEN"
C. Leslie Walker,
Mount Park Road,
Harrow.

L. WALKER writes to point out certain objections in the competition "Regulating Balloons." Though we do not feel called upon to answer any criticisms to our awards, we may in this instance point out the solution placed at the top did not win the prize, and was only placed there owing to a printer's error. Though it may be the case that "screw blades have little lifting power," they may have sufficient for the purpose. We understand that gas is constantly compressed in steel cylinders to 120 volumes by portable apparatus at Aldershot. We do not consider the prize-winning Solution perfection, else we should award 100 marks instead of 80.

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THE ILLUSTRATED

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Is the Earth's Centre of Gravity Fixed?

BY PROF. H. H. TURNER, F.R.S., &c.

WE have travelled far from the ancient idea that the earth was a fixture. For more than three centuries it has been realised that the earth rotates on its axis and revolves round the sun; and for more than a century that the sun and the whole solar system are travelling among the stars. Until a dozen years ago, however, the earth was regarded as a rigid body spinning about an axis *fixed in the earth*, so that the North Pole remained in precisely the same spot on its surface. Within the last decade it has been recognised that the North Pole executes a complicated waltz on the arctic snows, never straying more than 30 feet from its mean position, but wandering within this compass according to regular laws which have been formulated by Mr. S. C. Chandler, and found to agree satisfactorily with the numerous and accurate observations specially made at six stations established for the purpose in latitude 39° N., under the auspices of the International Geodetic Association. This movement of the North Pole, or "variation of latitude" as it is called, would probably have been discovered earlier but for the erroneous assumption that the earth was a rigid body. It is so far from rigid in reality that one of the principal figures in the dance of the Pole is executed in fourteen months instead of ten, so that investigations, which assumed a ten-months' period, always failed.

At the last meeting of the Royal Astronomical Society, Mr. Chandler drew attention to the fact that we may have to revise another of our notions concerning the immutability of the earth; its centre of gravity *may* not be fixed, but may oscillate every year to the extent of about five feet. This, or some other explanation, must be found for a curious phenomenon discovered by Mr. Kimura, who is in charge of the station at Misuzawa, Japan, one of the six above mentioned for observing the "variation of latitude." The new phenomenon is, in itself, a variation of latitude, but of a different nature from that resulting from a movement of the North Pole. If the North Pole comes slightly nearer Japan, so as to *increase* the latitude of Japan, it will be the same amount further away from Europe, and the latitude of Europe will be *decreased*. But the new phenomenon increases or decreases the latitudes of both Japan and Europe, and all the other stations simultaneously. It is of a totally unexpected kind, and cannot be explained by any cause with which we are at present familiar. A movement of the earth's centre of gravity alternately northwards and southwards along its axis would explain the facts as yet known; but how are we to explain such a movement of the centre of gravity? One possibility will doubtless occur to many readers; we know that masses of snow and ice collect at the North Pole in our winter, and at the South Pole in our summer. Is the transference of this mass from Pole to Pole sufficient to account for the displacement of the earth's centre of gravity? The answer is, however, clear. Not only is the amount insufficient, but it would have the *opposite effect* from that observed. We must, in fact, acknowledge that we are only on the threshold of the enquiry.

The object of Mr. Chandler's note to the Royal Astronomical Society was to suggest that another belt of latitude stations should be established in the southern hemisphere to test the phenomenon under different conditions. Three stations would, perhaps, be enough; and he pointed out that as two British observatories already exist in nearly the same latitude, viz., the Cape of Good Hope and Sydney, it would be thoroughly suitable for us to establish a third, also in that latitude, but in South America, and thus make the enterprise entirely British. Whether we can do this remains to be seen; but the Society recognised the importance of the suggestion, and determined to use its influence to get the project considered.

Wireless Telegraphy.

Mr. Andres Bull's Selective System.

OF the problems which confront the wireless telegraphic engineer, the greatest is that of devising a system of isolating messages, and, subsequently, of localising them. According to Dr. Fleming, the isolation of the messages from the big power stations, such as Poldhu, is so far established that the oscillations sent therefrom need not affect other instruments. It is still, however, within the power of the operator at another instrument to "incline his ear" to the message; and, therefore, the isolation is far from perfect: and the localisation of messages farther off still. The first step to the solution of both problems will probably be taken when a more controllable means of sending out electric waves of great power and high frequency is found. Mr. Marconi and other inventors have already found a means of sending out what we may, perhaps, be permitted to call electric waves of great power, and have overcome the first difficulty which faced them of preserving the oscillatory character of the discharges—without which oscillatory quality there would be no wave motion. But these waves are still not sufficiently under control. One might say that they were shot out in a series of explosions with intervals between them in a fashion not unlike the successive explosions of a petrol motor. It is at present impossible to emit waves capable of producing sharp resonance like the waves emitted by a tuning fork. Messrs. H. T. Simon and M. Reich suggest that a solution may lie in the direction of some experiments that were made by Mr. Duddell some two years ago. Mr. Duddell, it will be remembered, exhibited, first to the Electrical Engineers and then at the Royal Institution, some curious characteristics of the sound waves emitted by the electric arc—called by him the "singing arc." But these characteristics had been found accidentally by him while superimposing an induced current on the current through the electric arc, and were regarded by him as of very inferior importance to the excessively high alternations of current produced by his method. His appreciation may turn out to be right, and the current through the arc—broken up into sharp waves whose frequency may be judged by the pitch of the "singing arc's" note—may furnish an implement for sending out controllable series of wireless waves. The frequency amounts to as much as 20,000 a second.

Pending the establishment of some system of perfect radiation of Hertzian waves, most wireless telegraphy systems depend upon the principle of electric resonance, in which the resonator is made to respond sympathetically to the emitted waves of the oscillator in virtue of the similarity of their electrical dimensions.

One method, however, which was mentioned by Dr. Fleming in his recent Cantor lectures, and for the description of which, as well as the illustrations we are indebted to the *Scientific American*, is independent of the rather variable symptoms of electric syntony. Mr. Andres Bull has designed a system which operates mechanically, and in which the dimensions of the sending and receiving circuits are not factors controlling the matter of selection, but, instead, a fixed rate of wave impulses actuate different receiving instruments in accordance with prearranged time intervals.

The instruments employed in the Bull system of selective wireless telegraphy are shown in the photographs, Figs. 1 and 2. The "dis-

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perser" and "collector," as Bull terms the transmitter and receiver, are combined in the apparatus illustrated in Fig. 1, *A*. This mechanism is connected by means of gearing to an electric motor, *B*, the speed of which is controlled by a Siemens and Halske brake regulator, *C*. The device represented by *D* consists of an electro-magnet connected with and automatically controlling the disc referred to. Fig. 2 shows a number of Morse registers connected with the collector or receiving apparatus.

In transmitting a wireless message an ordinary Morse key is employed. When the key is closed the current from the battery, Fig. 3, flows through and energizes the electro-magnet 2. This attracts an armature, to which is attached a clutch, the side elevation being shown in Fig. 4. Attraction of the armature serves to draw the clutch out of engagement with a pin, 4, on the disc, 3, and this permits the disc to rotate by frictional contact with the shaft, 5, at a speed of about five revolutions per second. In the course of each turn of the disc the pin, 3, closes the circuit, of which the battery, 7, and the electro-magnet, 8, form a portion, through the medium of the contact springs, 6.

If it is desired to send a dot the key is made to close the circuit for a period of less than one-fifth of a second, so that the clutch will engage the pin and bring the disc to a stop as soon as it has made one complete revolution. Thus the current flows through the circuit, which includes the magnet, 8, in the form of a single impulse. When it is desired to send a dash the key is held into contact for a sufficient period to permit the disc to revolve several times, when successive current impulses flow through the circuit at intervals of one-fifth of a second. This actuates the transmitter or disperser, consisting of a disc to which are attached four hundred steel springs, 9, positioned vertically near the periphery. The free ends of these springs pass through radial slots (as shown in Fig. 3) in an upper and oppositely disposed disc 10. These slots permit movement of the springs relative to the disc in a radial line only. The discs are mounted on the same shaft or spindle, which, in turn, is mounted vertically in the frame of the disperser. The shaft is rotated at the rate of one revolution per second. A brass ring, 11, is secured to the frame, and serves as a guide for the spring points, 9, so that when the disc revolves they slide either within a U-shaped groove, 12, formed by the ring, or within the ring itself.

Referring again to Fig. 3, a bronze arc, 13, whose ends conform to the angle described by the dotted lines, *a*, is inserted in place of the brass ring at that section. The bronze piece, 13, has a projection

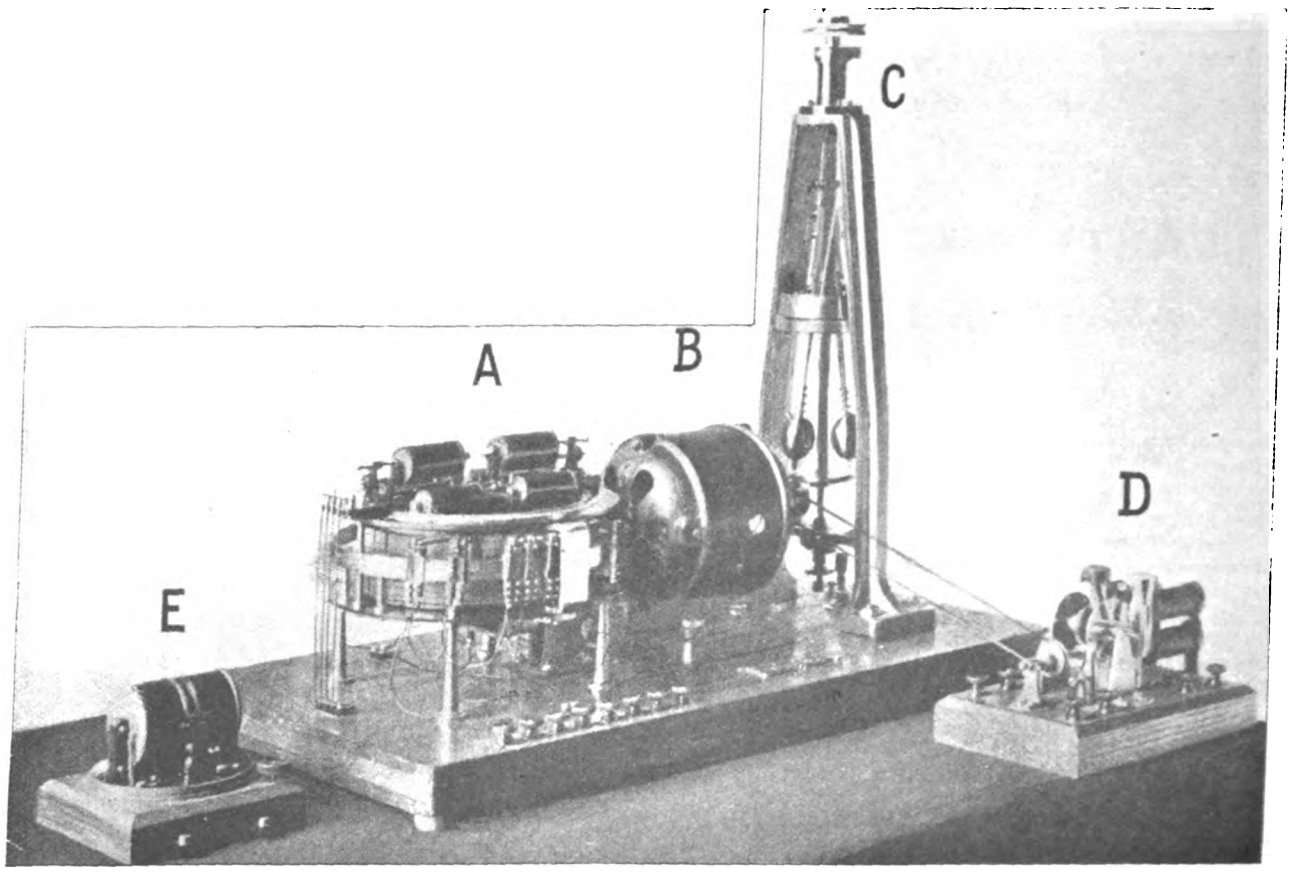

Fig. I.—Main Apparatus of the Bull System of Selective Wireless Telegraphy.

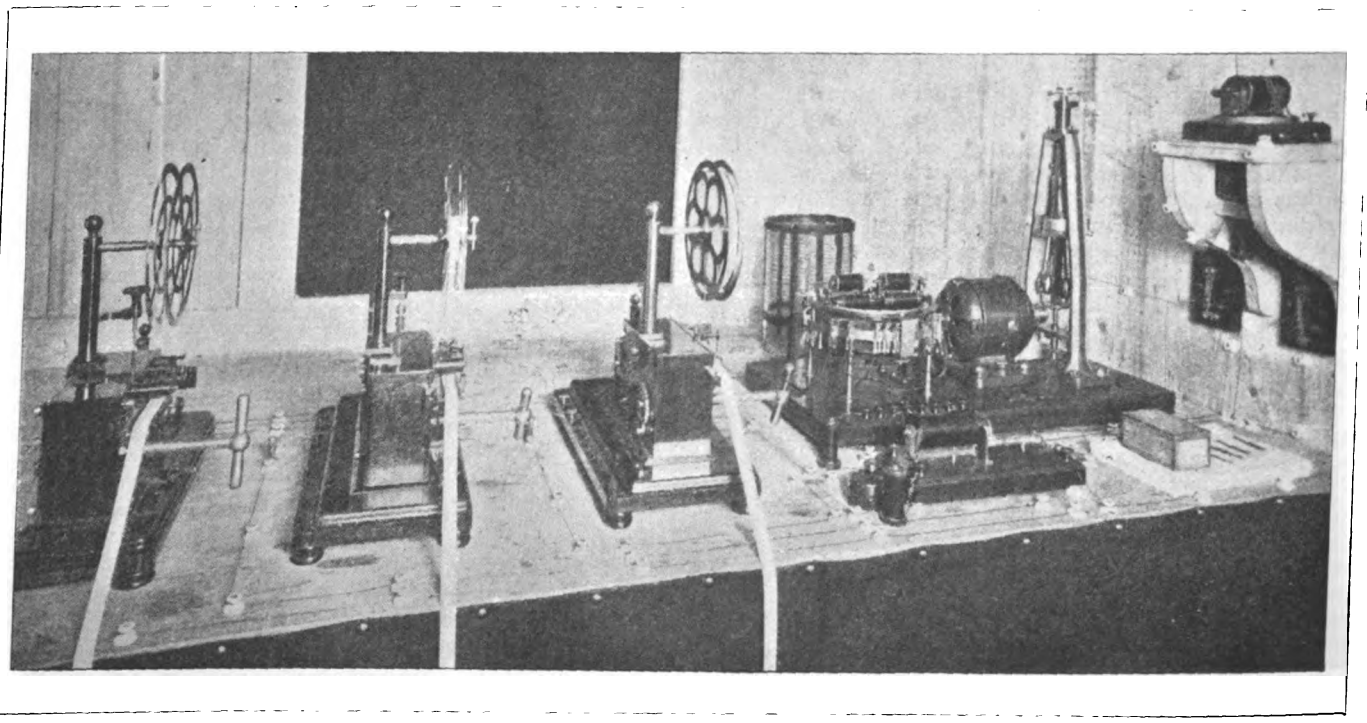

Fig. II.—General View of Mr. Bull's Receivers and Transmitter.

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extending toward the concentrically-arranged springs, and causes these springs in traversing this section to bend toward the polar projection of the magnet, 14, which then attracts them, being constantly energized by a current from the battery, 7. Thus attracted, the springs slide along the projection until the edge, 15, is reached, when they are released and instantly spring back into their normal position. As the discs continue to revolve, the steel springs simply slide within the ring, 11. This is the normal process which takes place when the magnet, 8, is not energized; but if the electro-magnet, 8, is excited, the armature to which the finger, 16, is attached, will be swung forward so that it projects slightly in front of the polar projection of the magnet, 14. When this occurs, the springs, in clearing the finger, 16, are forced from the pole of the magnet, 14, when they will again assume their vertical position in virtue of their elasticity, and will pass into the U-shaped groove at 17, remaining there until the disc has completed its cycle.

The purpose of this device is to establish contact at certain prescribed intervals with the induction coil, 20, and the oscillator, which emits the electric waves. This is done by means of a number of contact points, 18, fitted to the circumference of the frame supporting the disperser; these consist of two contact springs insulated from each other; when the steel springs, 9, move within the ring, 11, they just clear the contact springs, but when passing in the U-shaped groove, 12, they project sufficiently to make contact, and, therefore, close the circuit operating the induction coil.

If the magnet, 8, is not excited, and the disc is revolved, the steel springs will slide within the ring, and all the contact points will be open; if, on the other hand, the key is closed and a current impulse is sent through the magnet, the steel springs sliding through the groove make connection with each of the contact points in passing them. The electrical connections between the steel springs and the contact points, and the induction coil and oscillator system, is clearly

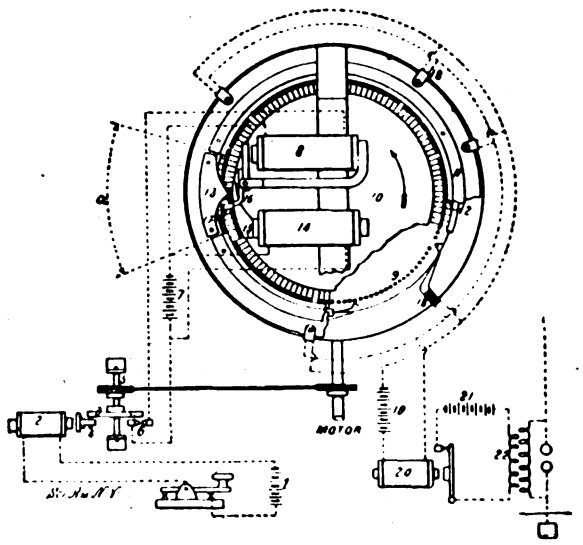

Fig. III.—The Transmitter, showing Connections between Disperser and Induction Coil.

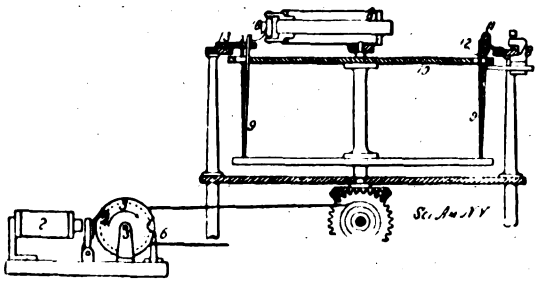

Fig. IV.—Sectional View of Disperser.

shown by the dotted lines, and it is evident that upon contact being established between a steel spring and the points, the circuit will be closed, and the current from the battery, 19, will operate the magnetic circuit closer, 20, thus causing the current from the battery, 21, to flow through the primary of the induction coil, 22, when a disruptive discharge takes place through the spark gap and electric waves are emitted. Now, for every current impulse that flows through the disperser magnet, 8, by means of the key, 1, a series of electric waves are radiated, which equal the number of contact points, 18, and since the discs revolve at approximately constant speed, the time intervals between a series of impulses will be proportional to the angular distances between the contact points, and thus, by varying the distance between these points, and by arranging these at different positions around the frame of the disperser, the series of impulses or waves may be varied at will and within wide limits. When the electric waves thus emitted impinge upon the receiving antenna (Fig. 5), the normally high resistance of the coherer is instantly lowered and the local current flowing through the coherer and relay magnets, 23, actuates its armature, closing an auxiliary circuit in which is included the decoherer, 24, for tapping the filings back to their normal resistivity, and the collector magnet, 25, which is in shunt with the tapper. The collector, as the receiving mechanism is termed, is constructed on the same principles as the disperser, Fig. 3; in fact, they may be substituted one for the other by means of proper cut-outs. It will, therefore, be clear that for each series of impinging waves a steel spring is brought into the groove of the ring, 26. The disc of the collector, to which the steel springs are attached, revolves at a speed isochronous, practically, with that of the disc of the disperser; hence the angular distances between the springs brought into the groove will be proportional to the time constant between the series of electric waves received by the antenna; *e.g.*, if five electric wave series are transmitted, five springs will be brought into the groove of the collector at angular intervals representing the intervals of time between the series of waves. The points, 27, making contact in the collector are arranged in the same

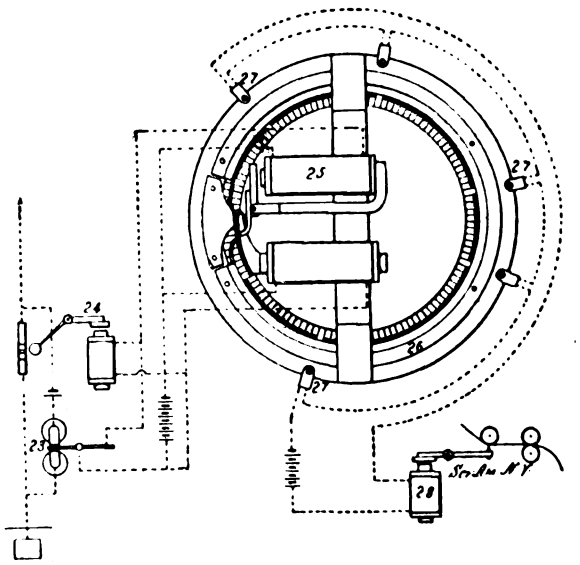

Fig. V.—The Receiver, showing Connections between Coherer, Relay, Morse Register and Collector.

relative positions as they are in the disperser, the springs moving in the groove forming the controlling contacts; these are connected in series with the Morse register, 28, and, consequently, contact is made by all the points simultaneously. Now, when the mutual angular value is the same for the points and the springs, a prearranged series of electric waves will bring the latter into the groove, and as the disc revolves the series of steel springs, corresponding to the series of waves, will make contact simultaneously at all points; the battery current operating the Morse register then flows through the circuit and prints a dot on the tape. A succession of wave series will produce a dash, or a row of dots reading as a dash. Wave series of any other combination than those to which the collector is adjusted will not operate the Morse register, for simultaneous contact is not possible, and the circuit is left open.

In the experiments conducted by Mr. Bull, only one transmitter and one receiver were employed, but the disperser was provided with three sets of contact points, 27, and was so arranged that any set desired could be operated by the induction coil, by means of a switch,

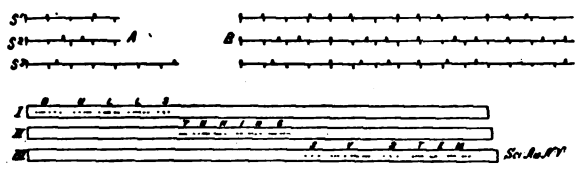

Fig. VI.—Diagram showing Impulses of Series and Specimens of Tape.

and thus, any one of three series of waves could be emitted and received at will. Uniformly with the disperser the collector was equipped with three sets of similarly-arranged contact points, each set being connected with a Morse register, enabling the operators to use any one of three combinations to the exclusion of all others. Three series or combinations of waves only were required, as shown diagrammatically by S^1, S^2, and S^3, Fig. 6 *A*. The element of time is represented by the horizontal line, and the wave series or combinations by the vertical heavy strokes; the equi-distant spaces marked by the vertical lines designate 0·05 of a second. At *B*, Fig. 6, is illustrated how the wave series are registered rhythmically when the key is kept closed. By this arrangement selective wireless messages were sent and received with accuracy and dispatch, and were printed in Morse characters on the tape of that register only for which it was intended, the other two machines remaining inoperative. Specimens of the tape from the three registers are shown at I., II., III, Fig. 6, each of the three series, S^1, S^2, and S^3, being employed successively. The speed attained approximated fifty letters per minute.

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The Latest Phase of British Locomotive Engineering.

MR. HOLDEN'S TEN-COUPLED TANK ENGINE.

FOR a considerable time past the authorities of the Great Eastern Railway have had to cope with a very difficult problem—that of dealing with the more rapid transit of the inhabitants of the populous East London districts, and the rapidly-growing suburbs which a section of the line serves.

Those who reside in the Eastern suburbs must know well the trials and doubts which attend the possibility of securing sitting, or even standing room in the morning and evening train services on some branches of the Great Eastern, and will welcome any advance which should lead to a surer method of reaching their various centres of the metropolis.

Some few years back, when the great problem was beginning to present itself, not only to the directors of the Great Eastern Railway, but to other lines in similar positions, coaches to seat six persons instead of five a-side, were introduced on the suggestion of Mr. James Holden, the locomotive and carriage superintendent of the railway.

The innovation was not sufficiently far-reaching, however, and the urgent necessity for increased accommodation, or an accelerated train service, became evident.

The electrification of the suburban systems was suggested, but the railway is not, nor ever has been, a rich one—composed as it is, more or less, of amalgamated light railways—and for this reason the scheme was thrown over. Then the problem commenced to be viewed in a new light, with the result that an enterprising railway engineer set to work to design a locomotive which should have a very high acceleration and tractive force in starting, which would enable it to pull an increased load of 50 per cent., and attain a speed of 30 miles an hour, at 30 seconds from starting. Not long since such a machine would have been considered an impossibility, but it now stands before us an accomplished fact, and Mr. Holden's new ten-wheels-coupled tank engine marks an epoch-making event in the annals of British locomotive engineering. That portion of the line which the new engines will chiefly serve—from Liverpool Street to Enfield—is about ten miles in length, and possesses an extraordinary number of stations. It has hitherto been worked by engines capable of attaining a speed of twenty miles an hour in thirty seconds from the start, with a load of about two hundred tons. It will thus be seen that about ten minutes will be saved on the journey, and the regular use of the new engines will allow of a much more frequent train service.

A MAMMOTH LOCOMOTIVE.

There are many novel and ingenious points about Mr. Holden's engine, which is certainly the most wonderful machine ever turned out of the Stratford shops. It may be doubted whether the new locomotive is, in point of size, the largest engine ever built in the United Kingdom, although it is certain that the heating surface far exceeds anything hitherto approached in locomotive construction in this country.

The external heating surface of the tubes amounts to 2,878.3 square feet, and that of the fire-box to 131.7 square feet, giving an unprecedented total of 3,010 square feet. The length over the buffer-beams is 37 ft. 9 ins., and it will be seen from our illustration that the height reaches the limit of the loading gauge.

Treating the boiler first, this has a length of 15 ft. 10 7-8 ins. between tube plates, and a mean diameter of 5 ft. 3 ins. The heating surface is given by 395 steel tubes of 1¾ ins. diameter, and the boiler pressure is 200 pounds to the square inch, which is relieved by no fewer than six safety valves. The fire-box is of a somewhat novel type, and is proportionately large. It is not particularly extended, but spreads sideways as far as the loading gauge will admit. As an instance of its capacity it may be stated that it will hold a ton of coal, while there is the enormous grate-area of 42 square feet.

THE MOTION.

The engine is driven by three high-pressure cylinders, two being placed outside, and the third between the frames, on the centre-line of the engine. The cylinder dimensions are 18½ ins. diameter by 24 ins. stroke. A peculiar feature of the cylinders lies in the fact that they are all placed in the same horizontal plane. In most cases in multi-coupled engines, the cylinders are placed at varying angles. The ten wheels, which are all coupled, are 4 ft. 6 ins. in diameter, and the rigid wheel-base, equally divided, is about 20 ft. Great ingenuity has been shown in the character of the inside connecting-rod. In order to clear the leading axle, Mr. Holden has made the rod pass round it; to accomplish this, the rod has been made very broad, and has an aperture through which the axle, which has to be cleared, passes. In order to effect the greatest strength, the coupling-rods have been made from solid steel forgings. A new method of joining the coupling-rods has also been introduced.

The balancing of the wheels—always a complex question—has been effectively solved by the designer. Mr. Holden explains the situation in a letter published in a recent number of the *Engineer*. He says that he at one time contemplated treating the engine mainly as a whole, and calculating the resultant balance-weight for rotating and reciprocating masses, and then dividing this weight equally between all the wheels; but this system, although reducing the actual balance-weights, would have put unnecessary stresses on various parts of the frame, and the method was abandoned. The system he ultimately adopted has resulted in each wheel being balanced independently as regards rotating-weights, and all reciprocating parts have, as far as possible, been balanced by weights equally distributed. It was not possible to carry this fully in the centre wheel, most of the available space having already been taken up in connection with the rotating balance. The centre wheel has lead weights—the lead being contained in a box-like structure cast on in one with the wheel-centre. The centre wheels have deep tyres, and are "blind"—that is to say, they have no flange.

SOME NOVEL INTRODUCTIONS.

Of the more important of the less vital "inventions" which Mr. Holden has fitted to his locomotive, the sand boxes, of which there are three, deserve a short description. The sanding gear is operated with a great saving of labour to the enginemen, as the actuating lever is attached to the regulator, and the rails are sanded with the one operation, of starting the engine. The sand is blown in either direction with compressed air from the Westinghouse brake air reservoir.

Each cylinder has a separate exhaust; the middle cylinder exhausts in the ordinary manner, but the outside cylinder exhausts are carried round to the top of the cylinders, and then, by pipes, into the smoke-box, to annular blast-pipes, which surround the central one.

The tank-capacity is small in comparison, though this is of no great consequence in an engine intended for suburban traffic; the bunkers will hold two tons of coal, and the tank, 1,300 gallons.

It has been questioned as to whether the designer was justified in his huge dimensions. "Is such a mammoth indeed necessary for suburban traffic?" It has been asked. The most competent authorities have had their say, and the result seems to show that Mr. Holden's innovation is irreproachable. During the half-minute of acceleration referred to in the commencement of this article, the engine must exert an average power of no less than 1,200 I.H.P. Of course, this effort will not be maintained, but the power is exerted at frequent intervals in starting, which would prove disastrous in a small boiler, because, with such a boiler, the draught and conditions of fire must vary to a very great extent. The pressure exerted in each cylinder when starting—with the boiler pressure of two hundred pounds—cannot be less than 24 tons.

The total weight of the engine is somewhere about 78 tons, the adhesive weight being at the same figure. Taking the mean effective pressure at 80 per cent. of the boiler pressure, we get a mean tractive effort of 36,507 lbs.

The engine has been numbered 20. Owing to the small space between the water-level and the crown of the domes, it is stated that the engine "primed" considerably on her trials, though this defect has since been rectified. It is also said that, in consequence of the great effort exerted in starting, the tensile strength of the carriage couplings will have to be greatly increased.

C. H.

Artificial Clay.

IT may seem rather remarkable that not only the most rare and precious products of Nature are imitated by the manipulation of commoner ingredients, but also some of those which seem to be of universal occurrence. One would have thought that clay existed in sufficient quantities to preclude any advantage of an artificial admixture of a similar character. But there are clays and clays, and those suitable for certain purposes are by no means common. A mixture of sand, chalk, cement, liquid glue, and petroleum, has been found to give excellent results in the manufacture of artificial stone and tiles. It acquires a good hardness after being subjected to heat, gives an even surface, is fireproof and damp-proof. Tests have recently been made at the Technical Experimental Station at Charlottenburg with very favourable results.

Spare the Birds.

IN a recent publication devoted to the interests of planters in the Southern United States the following interesting facts are placed on record respecting the value of birds in destroying insects injurious to crops:—

"In a single day the stomach of a single quail contained 101 potato beetles, and that of another quail 500 chinch bugs. A yellow-billed cuckoo shot at six o'clock in the morning contained 43 caterpillars, and another cuckoo 217 web worms. A robin had eaten 175 caterpillars. The stomachs of four chickadees contained 1,028 eggs of the cankerworm. Four others contained 600 eggs and 105 mature insects, and it is said that a single chickadee will eat 5,000 eggs of this worm in a single day. It has been estimated that a barn swallow will destroy from 5,000 to 10,000 flies and other insects every week. The crop of a dove contained 7,500 weed seeds."

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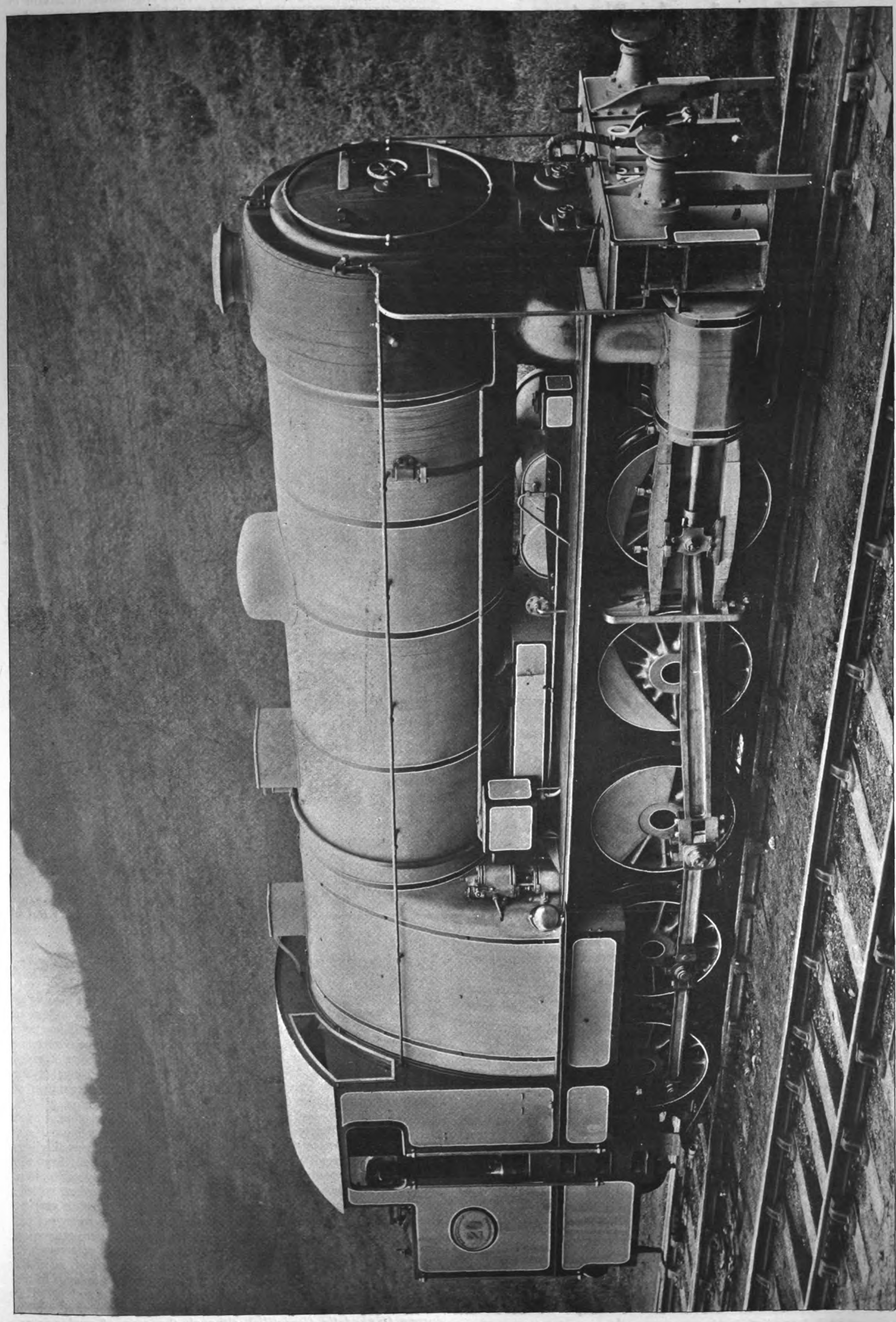

Mr. Holden's Ten-Coupled Tank Engine.

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Botanical Notes.

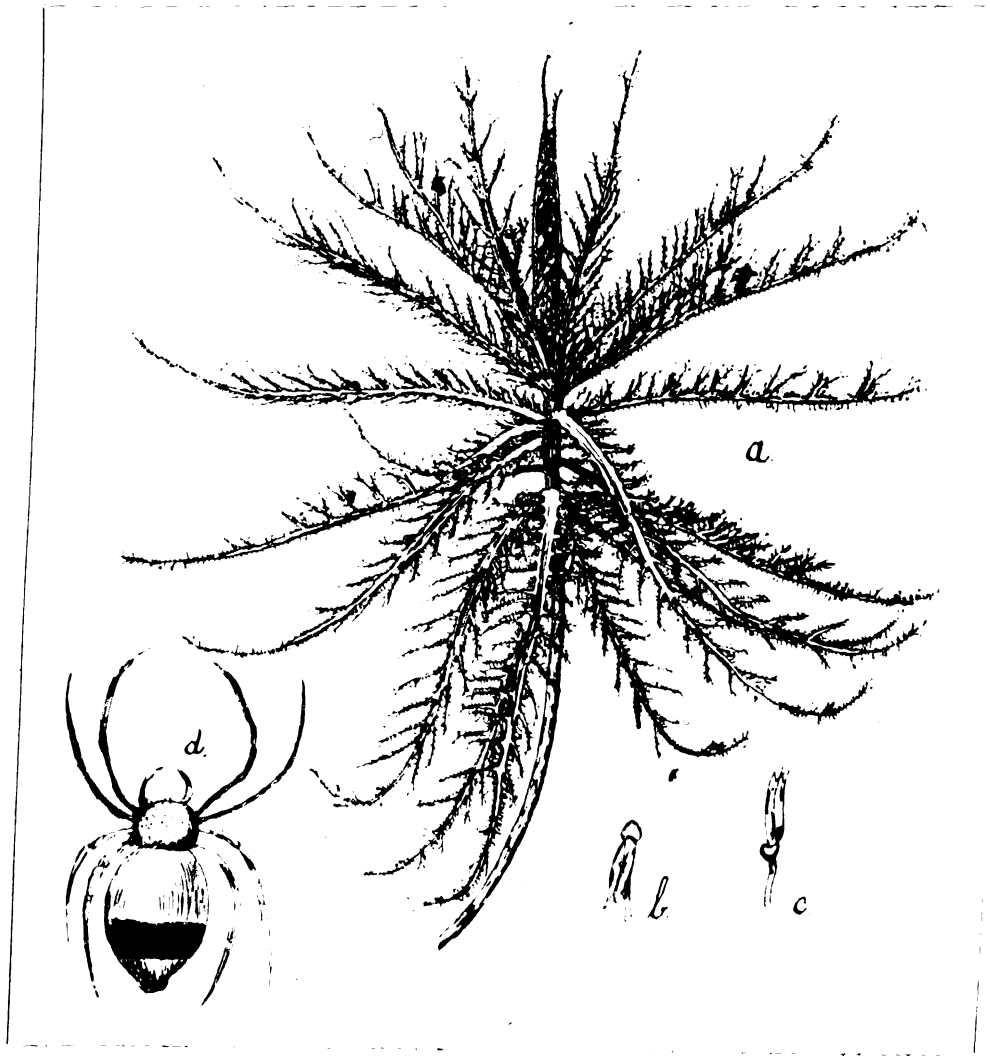
By F. E. FRITSCH, Ph.D., B.Sc., F.L.S.

A Complicated Relationship of Plants and Animals.

SINCE Darwin's days, the fact is generally known that a considerable number of plants exist possessing special arrangements for the capture of small insects and other animals, which are then slowly digested and absorbed. In our country the delicate little sundews (*Drosera*) are the doom of many an insect, frequenting the moist, mossy localities, where the *Drosera* flourishes; attracted by the bright colouring of the leaves and the numerous glistening and sticky tentacles borne on them, the little visitor alights on the plant to leave it no more, for as soon as any part of the leaves is touched, the neighbouring tentacles bend inwards and firmly enclose their prey. In other parts of the world we find such carnivorous plants of very different and varying shape. The Cape, in addition to forms resembling our sundews (which there, however, attain a much greater height), has a genus of insectivorous plants (*Roridula*, Fig. A.), which forms little shrubs of as much as four feet in height. These bear elongated, toothed leaves, covered with little tentacles, quite like those of the sundew in structure and function; for large numbers of insects are found adhering to the sticky tentacles of every shrub, so that the country people make use of the plant in their houses for catching flies. The tentacles of *Roridula* do not, however, perform movements like those of the sundew.

Now, although the large majority of insects is doomed, when once they touch a leaf of the plant in question, there is a little crab-spider (*Synaema*, Fig. D*), which is quite secure from the sticky secretion of the tentacles. The crab-spiders differ from most others, in that they do not form a web, but lurk in their nests until they can pounce out upon their prey. Large numbers of these tiny nests are hidden amongst the leaves of the *Roridula*, and serve in part as hiding places, and in part as a protection for young broods of spiders. As soon as an unlucky insect is caught by the sticky tentacles of the leaves the spider rushes out from its nest and devours the prey, thus using the plant as a living cobweb. Something similar has been observed in North Borneo in connection with another carnivorous plant (*Nepenthes*). This is one of the well-known pitcher-plants, occurring so abundantly in some parts of the world, and it is also often inhabited by a species of crab-spider (*Misumena nepenthicola*), which probably preys on the animals, entrapped in the pitcher. When frightened, it is said to plunge into the fluid at the base of the latter, emerging again when the danger is over.

But not alone the spider is proof against the sticky secretion of the tentacles of *Roridula*. There is a little Capsid, a species of Hemiptera, which is also quite at home on the plant in question, and has special nourishment provided for it by the latter. It is attracted by sugar, contained in the cells of the connective of the stamens, and which it obtains by perforating the organ in question with its proboscis. But in return for the food thus provided for it, it is made to serve as a means of transport of the pollen of the *Roridula* from one plant to the other. In the ordinary state, the anthers of the stamens are closely adpressed to the filament (Fig. B.), but any irritation, such as the probing of the insect after the sugar in the connective, causes the anther to swing round suddenly through an angle of 180° (Fig. C.), covering the Capsid with a cloud of pollen. This mechanism serves to effect cross-fertilisation. Thus the *Roridula* is inhabited by two animals, a spider and a Capsid, of which the former lives on the insects, captured by the plant, whilst the latter carries the pollen from one individual to the other, receiving nourishment in return, in the form of sugar, from the plant.



* Fig. D shows a North American representative of the genus *Synaema*.

Symbiosis between Algae and Sponges.

IN the older works on Zoology we shall find a considerable number of animals described, which are characterised by the green colour of their body; during the last quarter of a century, however, it has been shown that in most cases this green colour is not due to the occurrence of chlorophyll in the animal-body itself, but to the presence of green Algae belonging to various groups. Thus the green colour of the ordinary fresh-water sponge (*Spongilla*) is due to the occurrence of unicellular green Algae (*Zoochlorella*), which are capable of existing outside the sponge, just as the latter can do without the plant. Such a case of living together of two organisms without any mutual disadvantage is known as symbiosis; such cases pass over insensibly into true parasitism, in which one individual derives some benefit from the other. In this case the latter suffers without receiving any recompense from the parasite, which, however, is absolutely dependent on the presence of the host for its existence. On the other hand, it may be pointed out that the symbiosis between the Alga and the sponge is not very different from cases in which sponges grow as encrustations on Algae, or inversely where the latter flourish on the body of sponges.

In recent years a number of cases have been described, in which the Algae frequenting the sponge is not unicellular, but belongs to the more highly differentiated filamentous forms (see Figs. *a* and *b*). The sponge in question is another of the freshwater forms, not at all rare in Europe (*Ephydatia fluviatilis*), although the cases of symbiosis re-

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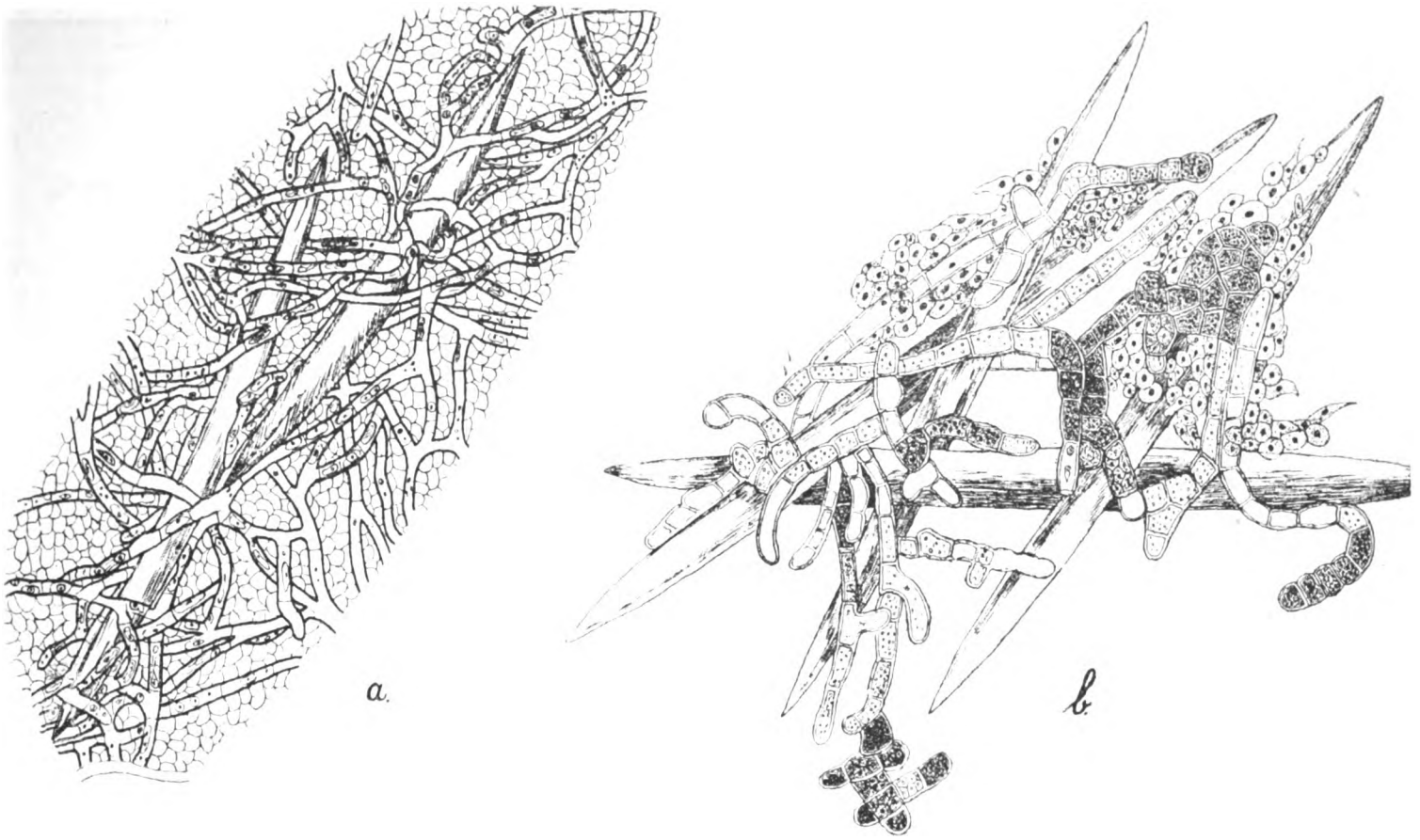
ferred to have been observed in Java and Sumatra. This sponge is almost invariably coloured green in the same way as *Spongilla*, and, as in the latter genus, this colour is often due to the presence of unicellular green Algae. In the tropical localities mentioned, *Ephydatia* often attains a great size and does not exhibit a uniform green colour, as in our waters: the main mass has a greyish-yellow colour, which is interrupted by numerous dark green patches. When these are microscopically examined we get the appearance shown in the figures (two distinct cases of symbiosis are figured involving two separate algal genera); the filaments of the Alga form entangled masses round about the large spicules of the sponge, and the tangle is often so dense that it is difficult to make out the details of the structure. The Alga spreads in all directions inside the sponge, and it is still an open question as to whether the tissues of the latter are only pushed on one side or whether they are destroyed—possibly partly absorbed by the plant. So that the sponge in these cases undoubtedly suffers somewhat by the presence of the Alga, but the former does not undergo deformation or ever die through the latter's agency, so that the harm done is apparently not very great. The sponge does not derive any visible advantage from the Alga; on the other hand, the latter is provided with an excellent supply of circulating water within the body of the sponge, which is continually drawing in water through innumerable pores all over its surface and giving it off again through a number of larger apertures. In addition to this the



Alga in these cases is one, which has not yet been observed living alone, and it is probable that we have before us a case of semi-parasitism (so-called space-parasitism), in which the Alga obtains a protective covering by its situation within the sponge. It has been pointed out above, that the Alga is principally concentrated round about the spicules of the sponge, whose defensive nature is sufficiently obvious.

A Parasite Destroyer.

In the *Agricultural News*, published at Barbados, attention is called to a new means of dealing with parasitic scale insects. In St. Lucia a ladybird beetle was recently observed eating scale insects, and appeared to be sufficiently useful to be worth spreading to other localities as a check on these troublesome pests. A first consignment of living beetles and their grubs was therefore imported from St. Lucia, and was received at Barbados on February 8. They arrived in good condition and were liberated the next day in the grounds of Queen's House. The beetle is of a steel blue colour, with small red spots on the head, and is a little larger than the small red ladybird beetle found so commonly in Barbados. It feeds on a variety of the common scale insects that attack mango, citrus and other fruit trees. Persons who may see it are requested by the authorities not to destroy it in mistake for a pest, for it is desired that this creature may increase and become established.

The Yeast of Grapes.

For some time the yeast of beer has been used as a means of treating boils and kindred affections. The employment of this strange "old wives' remedy," as it appears, is now justified by its results. How, then, does the yeast act?

It is supposed that the yeast, in the course of its own vital processes, secretes a substance capable either of neutralising the microbes and their toxins, or of multiplying the growth of the white corpuscles, or phagocytes, which are the militia of the organism. Whichever is the case, when it is produced, the curative action of the yeast is certain. Unfortunately, it is not always produced, because the yeast is not always in a condition to play its part for want of sufficient preparation.

The yeast of beer is a fermentation which is developed in a neutral environment (must) at a low temperature, and its evolution, apart from its customary neutritive elements, is incomplete. Introduced into the stomach, which is an acid receptacle and where the temperature is higher, the yeast languishes, and it is not long before it succumbs, like a fish out of water. It hardly has time before dying and being digested by the gastric juices to secrete a small quantity of the precious substance with which it should act upon the stomach's organism. Sometimes, even, when it is too old or too weakened, it secretes nothing.

It is here that M. Jacquemin, the learned director of the Institute of Malzeville, near Nancy, comes to the rescue. He has made a special study of the products of fermentation, which he cultivates for different purposes.

In place of the yeast of beer, the product of cold countries, M. Jacquemin substitutes another kind of fermentation (saccharomyces ellipsoideus), the product of the grapes of warm countries, accustomed to live at a temperature of thirty-five or thirty-eight degrees, and in a position, therefore, to bear the heat of the stomach. Moreover, he takes care to cultivate these "saccharomyces" in an acid environment, as a means of accustoming them beforehand to stomachic acidity, so that the ferment finds itself quite at home and in no wise inconvenienced there.

M. Jacquemin takes care, however, not to separate it from the nutritive elements necessary to its development, and he administers it to the patient with "eau sucré." There is then nothing to prevent the ferment from living at ease in the stomach and then disseminating abundantly its beneficial products. The result is the more certain, because the most minute precautions are taken to ensure that the yeast is absolutely pure from any extraneous matter or microbes.

Practice has justified the theory. Not only the pure yeast of grapes gives more surely the same results as the yeast of beer in the treatment of all eruptions of the skin, on which it takes effect in three days, but it has also certain specific virtues of its own. Nothing is equal to this cure in cases of loss of appetite, anæmia, chlorosis, neurasthenia. Perhaps, even, one may hope that it will prove efficacious in the treatment of diabetes.

In conclusion, we may observe that the ferment, continuing within the stomach the development that has already been begun outside, gives to the organism a stimulus to its digestive functions, and sends a redder and stronger blood through the veins. It is, in a word, the "grape cure," revised, perfected, and available at all seasons.

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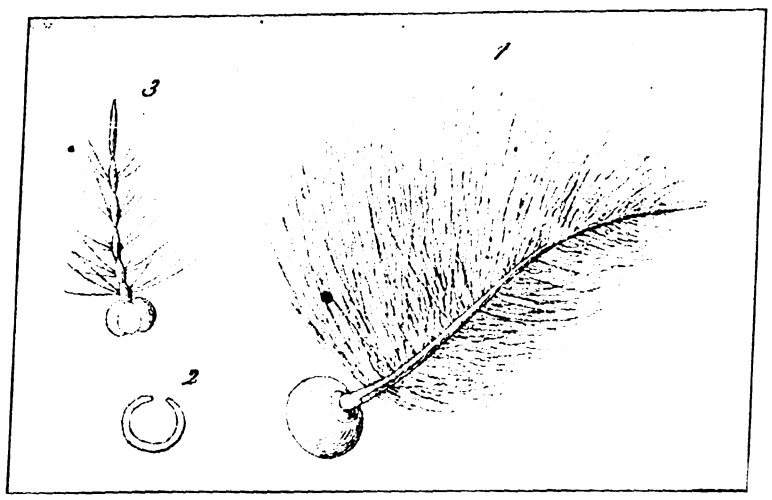
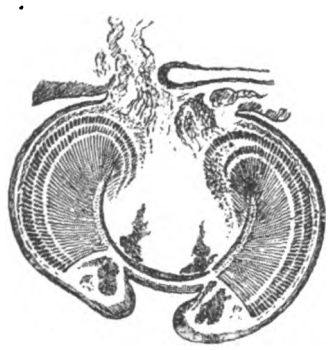
A Natural Wave Detector.

FOR the coherers and the other contrivances which have been found to record the passage and arrival of electric waves through the ether, Professor Fleming has suggested the name of "Kumascope," from the Greek word Κυμα, a wave. Among insects there are sometimes to be observed natural "kumascopes"—contrivances which indicate to the insect the arrival of sound waves. The most interesting of these is that possessed by the Harlequin Fly (*chironomus*); and it was described recently by Professor L. C. Miall, F.R.S., of the York-



Antennæ of the Harlequin Fly—(1) Male. (3) Female.

shire College, in the luminous and most suggestive dissertations on "Insect Contrivances" which he delivered at the Royal Institution. The structure and life history of the Harlequin Fly have formed the subject of a monograph* of singular interest and completeness, written by Professor Miall and Mr. A. R. Hammond, and it is by the kindness of the first of these naturalists that we have been able to reproduce from it the accompanying illustrations. It will be observed that the antennæ of the male Harlequin Fly (Fig. 1) differ very greatly from those of the female (Fig. 3). Those of the female are much shorter, having only eight joints compared to thirteen, and are without the

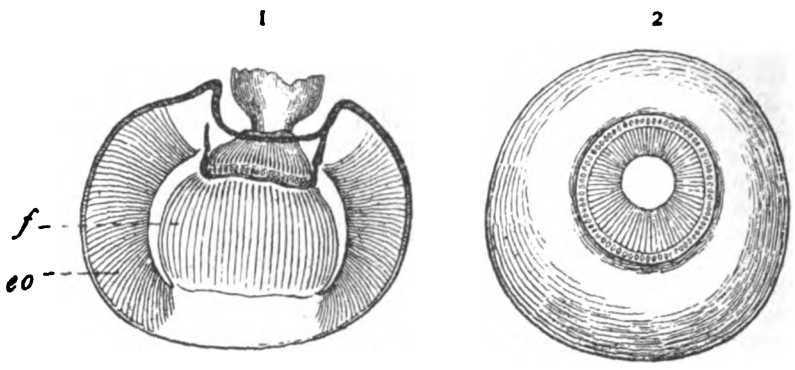


Segment Fibres at Base of Male Antennæ (Plan).

curious bristle or brush-like "setæ" or fibres spreading out from the antenna. In the male the second joint of the antenna is greatly elongated, and constitutes a peculiar sense-organ, which serves for the perception of sound. Each of the fibres to be seen in the first plate, stretching out on either side of the male antenna like the fibres of a peacock's feather, communicates with radiated striæ on the striated plate (Fig. 2). These striæ are connected with a regular and close-set layer of end organs. If the fibres of the "peacock's feather" brush are set in violent motion, the inner striæ are made aware of it, and communicate the fact to what we may call the brain of the insect. This violent vibratory motion in the fibres can be produced by sound waves of the proper vibratory kind—just as a tuning-fork can be sounded, or set in vibration, by another, similar to itself, sounded some distance away; or, again as a glass chandelier is sometimes set vibrating when a particular note is sounded on a piano.

Now many experiments have been made to find the kind of tuning fork that would set these fibres of the Harlequin Fly in vibration. A tuning-fork giving 512 vibrations a second caused a great amount of vibration, affecting not merely a few setæ of particular length, but many setæ together; other forks produced a much smaller effect. But it is by no means easy to sound the correct note on a tuning-fork. An expedient far more successful is to imprison a male Harlequin Fly, and then allow a female Harlequin Fly to approach the prison. As soon as the hum of her wings is heard the fibres of the tiny peacock's plume (not much bigger than a pin-point) on the male fly's head are set in vibration. Nor is this all. The auditory hairs, where

* "The Structure and Life History of the Harlequin Fly." By L. C. Miall, F.R.S., and A. R. Hammond, F.L.S. (*Clarendon Press*).



Base of Antennæ of Harlequin Fly.

direction is transverse to the path of the sound-waves, are most powerfully acted upon, while those which point to or from the source of sound are least affected. Hence the male can judge of the direction in which the female can be found.

"We suppose that in all cases the antenna of the male responds energetically to the note emitted by the female," says Professor Myers. "The note of the female Harlequin Fly (due to wing vibration) is 'B natural,' that of the male 'A sharp.' In both gnats and Harlequin Flies the male also possesses a sound-producing organ and the female a sound-perceiving organ; but this last is smaller and probably less efficient than the corresponding organ of the opposite sex."

The Maintenance of Solar Heat.

IN one of Sir Robert Ball's recent lectures at the Royal Institution he discussed the sources of the heat of the sun—the heat which it has been radiating away through space for millions of years. How is the sun able to continue this enormous expenditure of heat—exporting heat without visible means of import? The theory of Helmholtz was first reviewed by the lecturer. According to this theory, the sun is shrinking. It shrinks sixteen inches in diameter daily; it has been shrinking daily ever since it was a great gaseous nebula, extending over a millionfold greater extent of space. Now, the molecules of a body—we may, for clearness, think of a gaseous body and of the molecules of a gas—are in constant vibration while the body is radiating heat. If heat is added to the body, the rapidity of the motion of the molecules increases. Conversely, if the rapidity of the movement of the molecules increases, more heat is given out. Now, the falling in of the sun's circumference due to the sixteen inches of daily shrinking gives these molecules some distance to fall. It is not a great distance, but there are a great many molecules. Their motion is increased by their daily drop of sixteen inches. Consequently, this addition to their velocity adds to their heat, and thus by the sun's shrinking the supply of radiated heat is lifted towards the level of the expenditure.

But, Sir Robert Ball proceeded to show, this is not a complete or a completely satisfactory explanation. We may take it that in shrinking from its nebulous form down to its present dimensions the sun has given out heat equivalent to about 3,400 times its own mass in coal. Each coal unit would have lasted the sun 2,800 years. If we continue this calculation, and seek to find the number of coal units that the sun will have consumed between the time it was a gaseous nebula and the time when it shall become a solid body as dense as the densest substance known—platinum—we find that it will have consumed 8,300 coal units. In other words, roughly speaking, 24,000,000 years will have elapsed. But 24,000,000 years between the sun's gaseous nebulous state and the state in which it will become at least as cold as the earth is now, and cease practically to give out heat at all, is not enough. We know by various considerations that this estimate is too small, and, therefore, said Sir Robert Ball, we must begin to cast about for other possible sources of the sun's heat.

What other sources were there? The fall of meteors into the sun had been suggested, but Sir Robert Ball was able to show by a simple calculation that the quantity of meteors, travelling at 400 miles a second—the average speed of a comet—which would have to fall into the sun each day to keep up its heat would have to be equivalent in mass to the moon. But there were other things which moved quicker than comets and meteors. In the great blaze at Nova Persei it was perceived that portions of space had been reached by some emanation from the central blaze, so distant that the emanations must have travelled at the rate of 180,000 miles a second. Professor Kapteyn and Dr. Wilson had argued that these were light waves illumining distant spaces of cosmic dust or gaseous nebula. More lately it has been shown by Professor J. J. Thomson that the constituents of atoms, "electrified corpuscles" of matter, might move with speeds comparable to this. Consider the enormous energy that matter moving at this speed would have. A pound weight moving at 180,000 miles a second would develop an energy equal to 500,000 tons of coal. A single gramme, so moving, would be able to lift the British Navy to the top of Ben Nevis. And if in the whole past of time a quantity of matter equal to the earth in weight had rained into the sun with

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such a speed as 180,000 miles a second, then the sun's capacity for giving out heat would have been doubled.

Finally, Sir Robert Ball considered another point. The earth received heat from the sun, but the sun was radiating heat everywhere. If a spectator on the sun compared the space in the heavens occupied by the earth with that occupied by the great nebula in Orion, he would find that the earth occupied only one-two-hundred-thousandth part as much space as the Orion nebula. Therefore we had this fact, that the great nebula in Orion, though it was a million times farther from the sun than we were, was receiving 200,000 times as much heat a day. Now there were visible to our telescopes perhaps about 120,000 nebula—all giving out heat as the sun had been for ages giving out heat, and all of them sending out heat in all directions. If the nebulæ of the sky had all received heat from the sun then—and here was the point—the Solar nebula had received heat from the stars in its turn.

The Coca Plant.

THE coca plant, *Erythroxylon coca*, among others of medicinal value, is being experimentally cultivated in the Victoria botanical garden of the Cameroons. A firm of alkaloid makers in Germany, to whom some of the leaves were sent, found them to contain only 0.28 per cent. of total alkaloid. This low yield may be attributable either to improper drying of the leaves or deterioration during the long voyage. It is suggested that it would be advisable to extract the crude alkaloid for export, unless the leaves can be carefully packed in air-tight boxes without unduly increasing their cost.

Silica Glass.

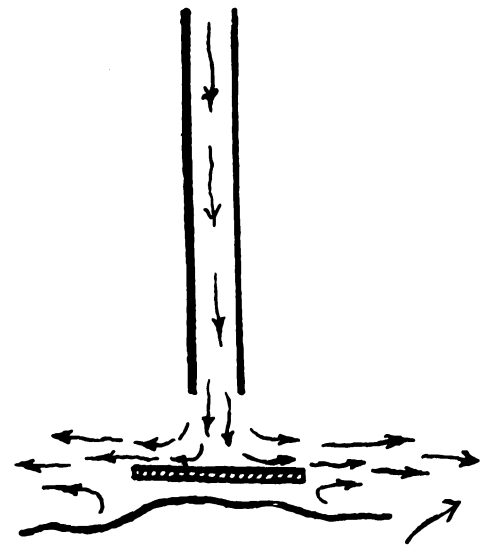
A RATHER disconcerting corollary to the article on "Silica Glass," which Mr. W. A. Shenstone, F.R.S., contributed to last month's number of the *Illustrated Scientific News*, is the fact that although the method of manufacture of this valuable scientific product was almost entirely due to him, yet the English manufacturer has allowed its mercantile development to leave this country. A firm at Hanau, a few miles from Frankfort, was the first to place quartz glass apparatus upon the market, and German papers state that the manufacture is now rapidly developing in Germany. The United States Consul at Frankfort says the manufacture of quartz glass is yet in its infancy, but has already shown symptoms of vigorous growth. "Everybody who knows the properties of quartz glass admits that it will soon replace ordinary glass for many uses. It is only a comparatively short time since German manufacturers revolutionised the manufacture of optical glasses and obtained a monopoly of this important industry, and there is reason to believe that this will be repeated with quartz glass. If quartz glass can be produced at a moderate price—and this seems to be quite possible where electric force can be cheaply obtained from water-power—it will no doubt be largely employed, especially in the chemical and electrical industries."

Attraction by Blowing.

A CURIOUS AND INEXPLICABLE EFFECT.

AERODYNAMICS and the movements of currents in fluids is a subject not at all well understood, and many simple little experiments can be made, the effects of which are not easy to account for. Among the most inexplicable are the following :—

Take a tube (rolled up piece of paper) about a quarter of an inch in diameter. Lay a small piece of thin paper on the table. On blowing down through the tube on to the top of the paper, the latter



is, naturally, pressed closer against the table. But now interpose a coin about half an inch below the tube. On blowing, the paper will at once rise up to the coin, and will remain there so long as the air current is kept going. It may even be found to be possible to lift the paper even though only a corner or small portion of it be beneath the coin.

The only explanation we can suggest is that the air being driven away from the edges of the coin in a horizontal plane induces a vacuum and consequent upward current below the coin. But there is another modification of this experiment which seems to call for another explanation.

Around the lower end of the tube place a disc (cardboard) 3 inches across. On now blowing through the tube close over the paper, the same effect will be produced without any coin, the paper rising up and remaining fixed partially over the orifice so long as the blowing is continued.

It might be suggested that the air in passing round the paper eddies round and supports it from underneath. But then it seems remarkable that these should be stronger than the current blown down the tube. Moreover a piece of paper larger than the disc can be drawn up.

We should be glad to hear if any of our readers can suggest a better explanation.

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Inoculation for Typhoid Fever.

IN a recent number of the *Illustrated Scientific News* we described the methods of preparing the typhoid vaccine, according to Dr. A. E. Wright's method, which has been for some years in use in the British Army; and the use of which we regret to see is officially being discontinued without sufficient reason, or, as we think, without sufficient trial. Other experiments in the direction of finding not a vaccine, but a serum for use as a preventive or curative in cases of typhoid or enteric are being made by Dr. Allan MacFadyen at the Jenner Institute of Preventive Medicine; and these experiments, besides being of the highest possible interest, hold out the promise of proving of the highest possible clinical value. In another direction, Dr. Chantemesse, of Paris, has been experimenting with what is called (with rather insufficient exactness) an anti-typhoid serum, which is used in somewhat the same manner as Professor Wright's "typhoid vaccine." At the recent International Congress at Cairo, Dr. Chantemesse read a paper showing the actual progress made by his system of inoculation in typhoid fever cases. The system has now had some three years' trial. As in the case of Dr. A. E. Wright's anti-typhoid vaccine, the final test of the efficacy of Dr. Chantemesse's method is the statistics of the cure or alleviation of typhoid effected by it. Dr. Chantemesse has observed cases of typhoid fever in the great Parisian hospitals, during a period of twenty months, and compared them with cases treated at a military hospital under his special care. In the hospitals hydrotherapic treatment, or ordinary pharmaceutical methods are applied; at Dr. Chantemesse's hospital only hydrotherapy and antiphoidal serum are employed. In the hospitals Hotel-Dieu, Laviboisiere, Saint Antoine, Tereon, Boucicaut, Broiessais, etc., the total mortality, variable in each hospital, amounted to 19.3 per cent. from the first of April, 1901, to the first of December, 1902. Everywhere the average of mortality remained above 12 per cent. During the same time, on the contrary, at Dr. Chantmesse's own hospital, out of 186 cases, seven died, a mortality of 3.7 per cent. It is evident that such different percentages cannot be accounted for by chance. Therefore, the anti-typhoidal serum must possess real efficacy.

But there were seven deaths. Dr. Chantemesse explains the failure of his treatment in these instances in an account of each individual case. There were other maladies besides typhoid fever; infectious illnesses, and afterwards peritonitis with intestinal perforation or obstructions. The serum cannot cure these cases.

The statistics for last year are more encouraging still than those of 1901. Taking all the cases together we find out of 507 cases treated by serotherapy a mortality of 6 per cent. And, to begin with, Dr. Chantemesse did not understand his serum so well, and manipulated it less surely. Practise is necessary. For instance, M. Rouvier, director of the marine hospital at Toulon, tried the method on 171 typhoid patients, inoculated by Drs. Plaute and Foucault; 13 cases died. The result, although favourable, was less so than in Paris. Dr. Chantemesse considers that it is due to the fact that these doctors are less accustomed than himself to the manipulation of the new remedy, and that its application has been less complete than in his own hospital.

If one considers the best results of serotherapy, in the German army, for instance, in which last year there were only 9½ per cent. deaths (929 cases with 87 deaths), it is obvious that the mortality among typhoid cases treated by the serum is still distinctly smaller than where ordinary treatment is applied.

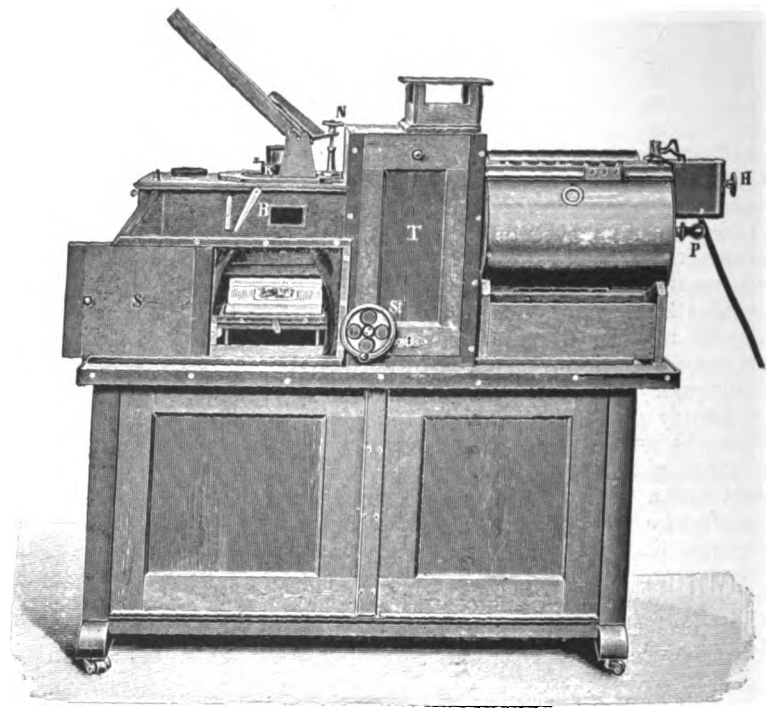
All this is very hopeful. However, as Dr. Chantemesse says himself, 507 cases treated by serum are not sufficient to furnish a definite pronouncement on the new method. Thousands of cases, and years of observation are required for that. Meanwhile, it is useful to multiply experiments, and it is to be hoped that Dr. Chantemesse and his colleagues will make them everywhere, and in all climates. A reduction in the rate of mortality—from 19 per cent., from 10 per cent. even, to 5 per cent.—would show already considerable progress.

The Biological Bent.

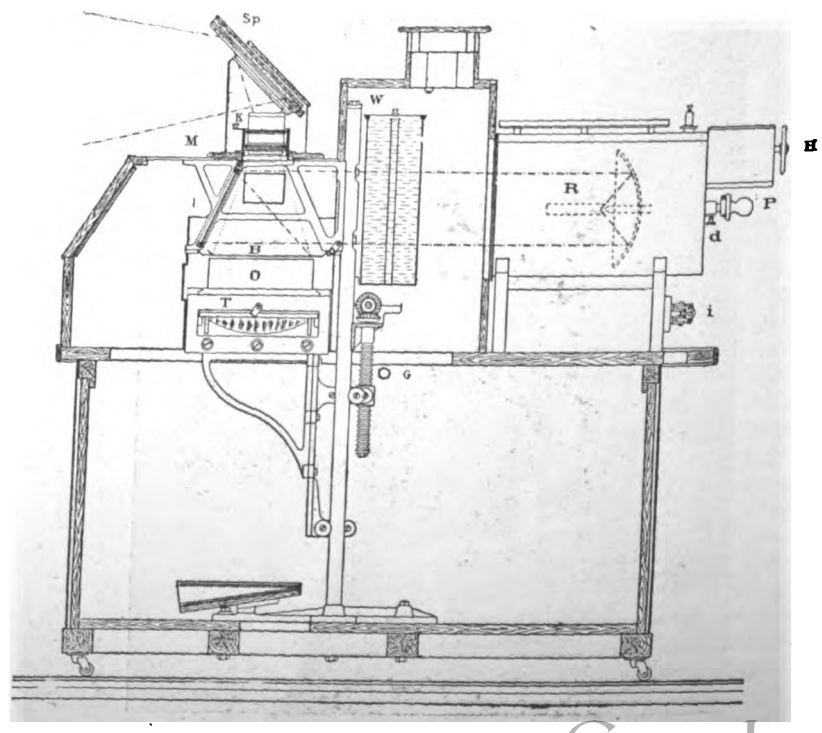
DR. A. R. WALLACE, the last of the "dauntless three," who kept the bridge for the cause of Darwinism, has recently given to a correspondent the reasons which induced his early interest in biology:—"As to my interest in biology, I can trace it I think to two very trifling facts. I doubt if I had or have any *special* aptitude for it, but I have a natural love for *classification* and an inherent desire to *explain things*; also a great love of beauty of form and colour. The two slight facts are these. When a boy at school I heard a Quaker lady say that she and some friend had found the 'Monotropa,' which was quite a discovery as being before unknown in the district. This, and hearing the names of other flowers referred to as rare, made me think it would be very interesting to know the names of all the plants that grew wild, but as I had no botanical friends the wish remained dormant, till I was about 15, when I purchased for a shilling (I think) a little book on botany published by the *Society for the Diffusion of Christian Knowledge*, and which contained the characters of about a dozen of the commonest natural orders in Britain. This was a revelation to me, and kept me employed for a year or two determining the flowers I met with if they belonged to any of these few orders. I then bought Lindley's 'Elements of Botany,' I think it was, but was disappointed in finding no more 'orders' described, but details of structure which did not much interest me. When recovering from a serious illness I met with Loudon's 'Encyclopædia of Plants,' and finding that this contained brief characters of all British plants, I amused myself by copying them *all*, except I think the grasses and sedges, on sheets of note paper, which I interleaved in Lindley's volume, and by means of these I was able to determine most of the species I met with, and made a considerable herbarium. The other incident was meeting H. W. Bates at Leicester and being started by him as a beetle and butterfly collector. The enormous *variety* of form and structure in the beetles attracted me, and I think during all my tropical experiences the collection of these gave as much enjoyment as even the gorgeous birds and butterflies. Classification then began to fascinate me, through Swainson, and the 'Vestiges of Creation,' with the works of Herbert Spencer, started me on the problem of the origin of species; and thus my various mental tendencies had full occupation in the contemplation and study of natural objects. I also, very early, became interested in geology, in mechanics, in physics and in astronomy, and this breadth of scientific interest, though with no direct education in any one of them, has been of great service to me in preventing a too exclusive attention to any one aspect of nature."

The Epidiascope.

THIS instrument, lately introduced by Mr. Carl Zeiss, should prove of the greatest use to lecturers and others, as it enables them to throw on



The Epidiascope.



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to a screen the enlarged image of any objects laid on the table within the apparatus.

An electric search-light, with a continuous current of either 30 or 50 ampères, is the source of light, and this is reflected through a plate-glass tank of water to absorb the heat rays, and is then reflected by a mirror on to the objects lying on the horizontal table. Above the brilliantly-illuminated objects is the lens, which throws an image on to the "erecting mirror" placed at an angle of 45°, and thence on to the screen. The latter, two to three metres square, is made opaque (if necessary, by painting with distemper), as it is found that the ordinary sheet allows too much light to pass through.

In this way an enlarged image of the objects, which may be drawings or even printed matter, is projected on the screen, and may be magnified as much as 25 diameters. By substituting a photographic plate for the screen, an enlarged photograph may be obtained, a specimen of which we reproduce.

By a slightly different arrangement of the reflectors, the light can be transmitted from below through transparent or translucent objects.

Objects Projected on a Screen by the Epidiascope.

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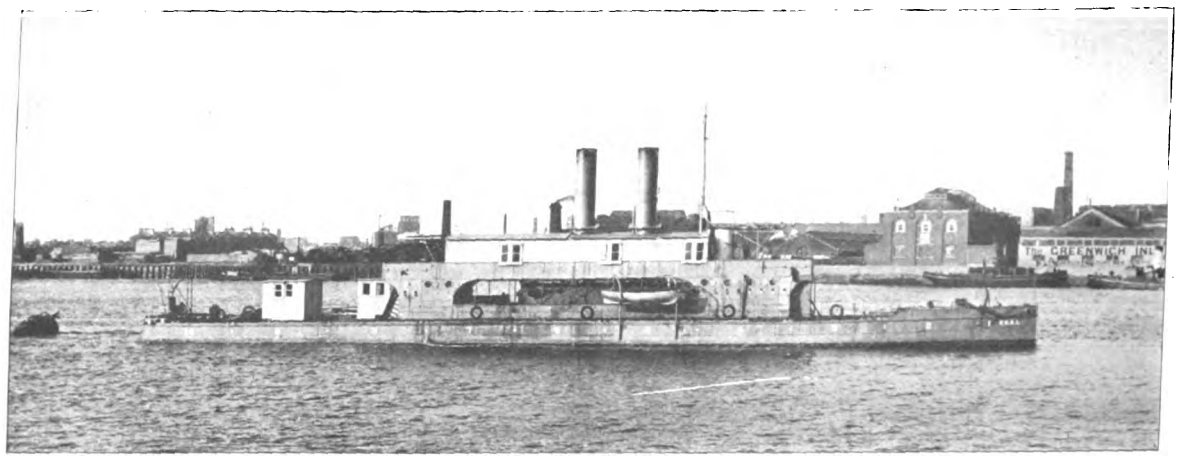
Shallow-Draught Gunboats.

IN the first number of the ILLUSTRATED SCIENTIFIC NEWS a description was given of the device invented by Messrs. A. F. Yarrow for situating the propellers of boats which were to be used in shallow waters, in a tunnel beneath the boat. One might compare the tunnel to a cavity like the inside of a spoon. As the screw revolves the water fills the cavity and thus the screw has more water to work in than the boat is actually drawing. In the article quoted reference was made to H.M.S. *Teal* and *Moorhen*, which are now being used to patrol the Chinese rivers. We give a photograph of H.M.S. *Teal*. The gunboat, besides its advantages of light draught, answers admirably several other requirements. The duty for which these vessels were designed was to obtain a speed of 13 knots, equivalent to about 15 statute miles an hour, when carrying a load of 40 tons on a draught not exceeding 2 ft. 3 ins. All the machinery and fighting spaces were to be protected by rifle-proof plating, and the fuel to be used was wood only. The system of propulsion adopted by Messrs. Yarrow in this case was that of twin screws, revolving in the specially designed tunnels. There are two sets of compound surface-condensing engines, with a speed of about 300 revolutions per minute. There are two Yarrow water-tube boilers, of the usual straight-tube type made by this firm. The space available in these little vessels has been skilfully utilised for the accommodation of officers and crew. The former are berthed in well-fitted cabins between the main and battery decks; the armour protection being loopholed for rifle fire. Forward, there is a cabin divided to form a ward-room and commander's cabin; this is fitted for three officers. Aft of this there is a cabin which will accommodate eight petty officers. The arrangements for the crew are made for natives, and there is a specially-fitted sick bay. The magazines are placed below, ammunition hoists passing through the cabins, so that there is direct communication, under cover and protected from shot by the cabin plating, between the magazine and the battery deck.

The vessels have square sterns, and in order to insure quick manœuvring powers—very necessary when navigating crooked rivers, often full of shallows—there are four rudders, which can be actuated either by steam or hand gear. There is a fan in the stokehold, for forced-draught purposes. This was not in operation during the official trial, but is intended to be used under exceptional circumstances, when only wood of an inferior character is available for fuel.



The Shallow-Draught Gunboat "Teal."

Light without Heat: A Bacteria Lamp.

SOME months ago we referred to some marvellous luminous worms found in South Africa, and used by the soldiers as illuminants. Reference has also been made to the fact that glow-worms and fire-flies emit light without heat. Could such a light be introduced into everyday life, it would prove invaluable, as at once doing away with all risk of fire. Professor Hanos Molisch, of Prague, now claims to have made a lamp, the light of which is derived from bacteria. The lamp consists of a glass jar, in which a lining of saltpetre and gelatine inoculated with bacteria is placed. Two days after inoculation the jar becomes illuminated with a wonderful bluish green light, caused by the innumerable bacteria which have developed in the time. The light will burn brilliantly for from two to three weeks afterwards, diminishing in brightness. It renders faces recognizable at a distance of two yards, and large type is easily legible by it. Professor Molisch asserts that the lamp yields a cold light which is entirely free from danger, thus being valuable for work in mines and powder magazines.

The Mathematical Eye.

A WELL-KNOWN mathematical tutor used to range his pupils according to their possession of what he called the mathmatical eye—an attribute which he believed could be acquired, but was capable of acquirement only in a limited degree. Dr. A. B. Halsted, in a letter written to Professor Cockerell, remarks that about one person in two hundred has some sort of mathematical genius. He continues:—"One in two hundred university students has marked mathematical ability. Of those who do not get to any university the percentage may be just as high, since only race, and not caste, is necessary for this gift. A Hindoo has just been Senior Wrangler at Cambridge, England; and Gauss was a bricklayer's son. No one with a drop of African blood has ever given us a theorem in mathematics. Shaler accounts for the stupidity of the Romans in mathematics by supposing that the primitive basal race in Italy was from Africa. There is a marked difference between ability in geometry and ability in arithmetic and algebra. The Jews give us more great mathematicians than any other race, but never a geometer. Geometry is hindered by a necessity for visualization. Todhunter said with penetrating wisdom that the person who had to see the relations definitely on a figure could not go on in the higher mathematics. Non-Euclidean geometry, my subject, cannot be visualized. Calculating prodigies are usually idiots, absolutely lacking in power of visualization. Most eminent mathematicians are deficient as calculators, some do not know their multiplication table. . . . I have never in my life had to extract a root of a number. The thing which seems most to foster mathematical ability is use in very early youth, strong stimulation in early youth."

Stimulants and Plants.

IT is not possible to intoxicate plants, in the ordinary sense of the expression, but it is possible to treat them so that they will appear to be under the influence of stimulants. The stimulant is ether administered to them in an air-tight bath or box. One of the plants that have been successfully operated on in this way is the lilac, the object being to induce it to develop flower spikelets at quite abnormal and unusual seasons of the year. In the first place, the shrub to be operated on is placed in an air-tight box, into which a small vessel containing ether is introduced. Here it is allowed to remain for forty-eight hours, after which it is removed and placed in the open air for a similar period. Then it is replaced in its ether bath for another forty-eight hours, and after this process has been continued for another time or two, the plant begins to grow very lively, and to throw out flower buds in the usual spikelet fashion. These buds coming at an unusual period of the year, generally in the late autumn—for that is when they are in most request for decorative purposes—will, of course, fetch a great deal of money. They have been obtainable before at these unseasonable times, but by quite another process, viz., retardation, that is, by being kept at such a low temperature at the usual budding period of the year, that they would not flower. After that, when the flowers were wanted, the shrubs were placed in a forcing house and subjected to great heat, when they would begin to bud.

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The Greatest Power Station in England.

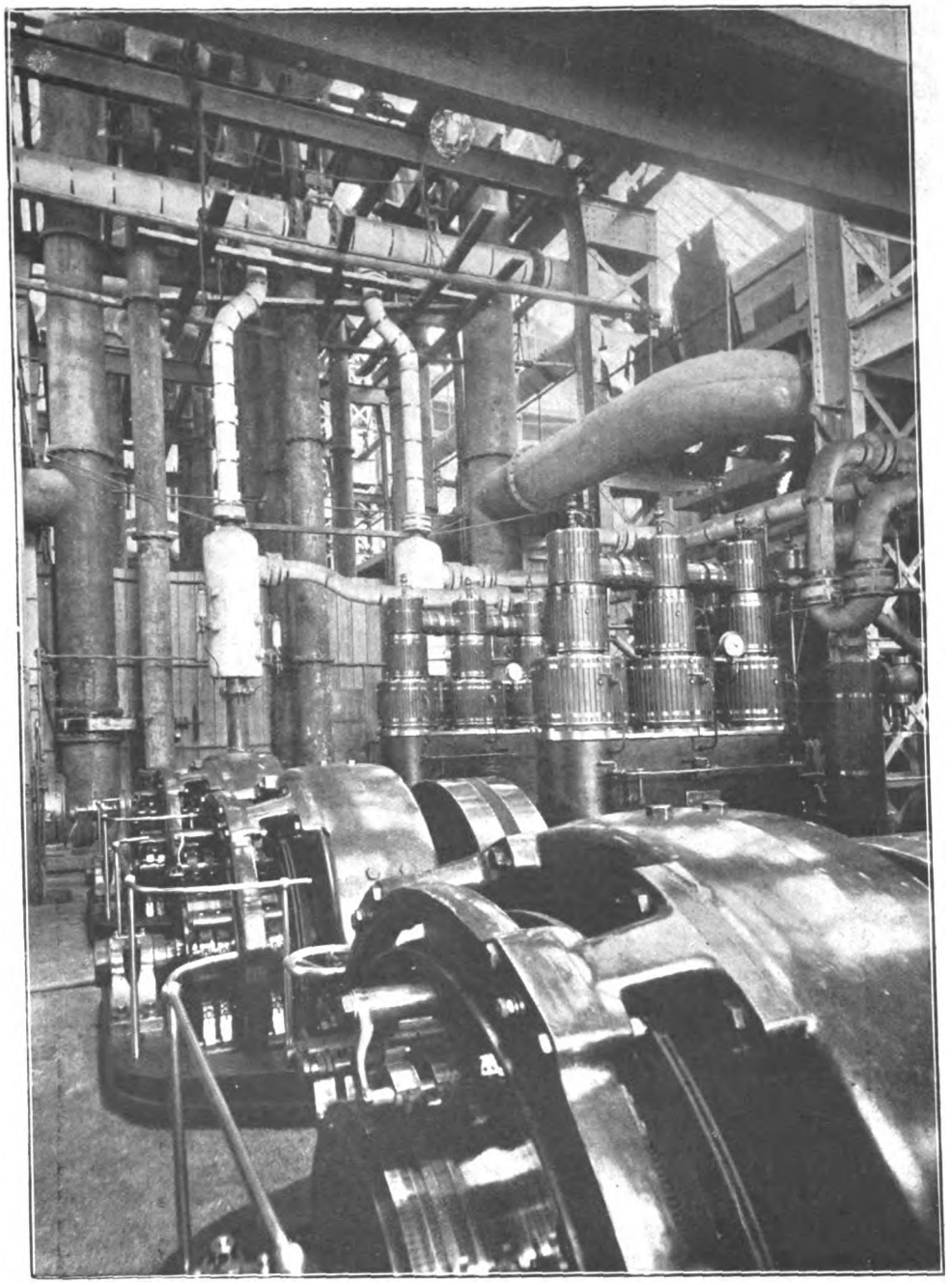
THE completion of the Manchester Corporation's electricity system will raise the installation to a position of magnitude, which will be approached by few others in the world. The total horse-power available at the various works will be 58,000 i.h.p., and the length of cable required to transmit the current no less than 360 miles. The Tramways Committee alone require current for 800 cars, and the lamp connections amount to half a million eight-candle power lamps. Nearly 20,000,000 electric units are sold during the year. The two sections of electric power distribution are known as Dr. Kennedy's and Mr. Metzger's schemes. The centre of distribution is the Stuart Street Generating Station, which, pending the building in London of the Lot's Road Generating Station for the London County Council Tramways, is rightly to be described as the greatest power station in England. Here three-phase alternating currents of a frequency of 50 cycles per second are generated at an "extra high pressure" of 6,500 volts, and are transmitted at this pressure to the sub-stations. The supply from the sub-stations is at 500 to 550 volts pressure for supply to the tramways, and at 410 and 205 volts pressure for lighting and power purposes.

The ten sub-stations in connection with the first installation of 15,000 h.p. are situated as follows: (1) Bennett Street, Hyde Road; (2) Polygon, Ardwick; (3) Elbow Street, Levenshulme; (4) Denton; (5) Heaton Moor Road, Heaton Norris; (6) Wilmslow Road, Rusholme; (7) Denmark Road, Moss Side; (8) Ladybarn Road, Fallowfield; (9) Marriott Street, Withington; (10) William Street, Didsbury.

The size and arrangements of the various sub-stations differ slightly to suit the demands and the available sites in the different districts, but the general design is the same in each case.

Taking, say, the Bennett Street Sub-station as representing the standard design:—

The building is divided into two bays of 35 ft. 6 ins. span and 23 ft. 6 ins. span respectively. The larger bay contains at one end the traction motor generators, and also the high-tension and low-tension traction switchboards. At the other end of this bay are placed the lighting motor generators and balancing sets, and the corresponding high-tension and low-tension switchboards. In the smaller bay, two additional traction motor generators are placed, and space is provided for further extension traction sets, and for extension lighting sets. An overhead crane, worked by hand, is provided for each bay. This we might call Dr. Kennedy's scheme. The extension planned by Mr. Metzger, the Council's engineer, includes ten more sub-stations, situated in the following districts: Stuart Street, Harpurhey, Oldham Road, Sherbourne Street, Cheetham Hill, Openshaw, Newton Heath, Queen's Road, Whalley Range, and Chorlton-cum-Hardy.



The Manchester Corporation's Electricity Works—The Stuart Street Generating Station.

Some idea of the magnitude of the installation at the Stuart Street Generating Station may be gathered from the accompanying photographs, for which we are indebted to the Sir Hiram Maxim Electrical Engineering Company, who are responsible for the "pipe work," and have taken a noteworthy share in the assembling of the plant. The feed tanks and steam mains to be seen in one of our illustrations, and the great boiler room are splendid examples of their engineering work. The following description of the boiler house, etc., will be of interest: The boiler house is 94 ft. wide and 200 ft. in length, and is

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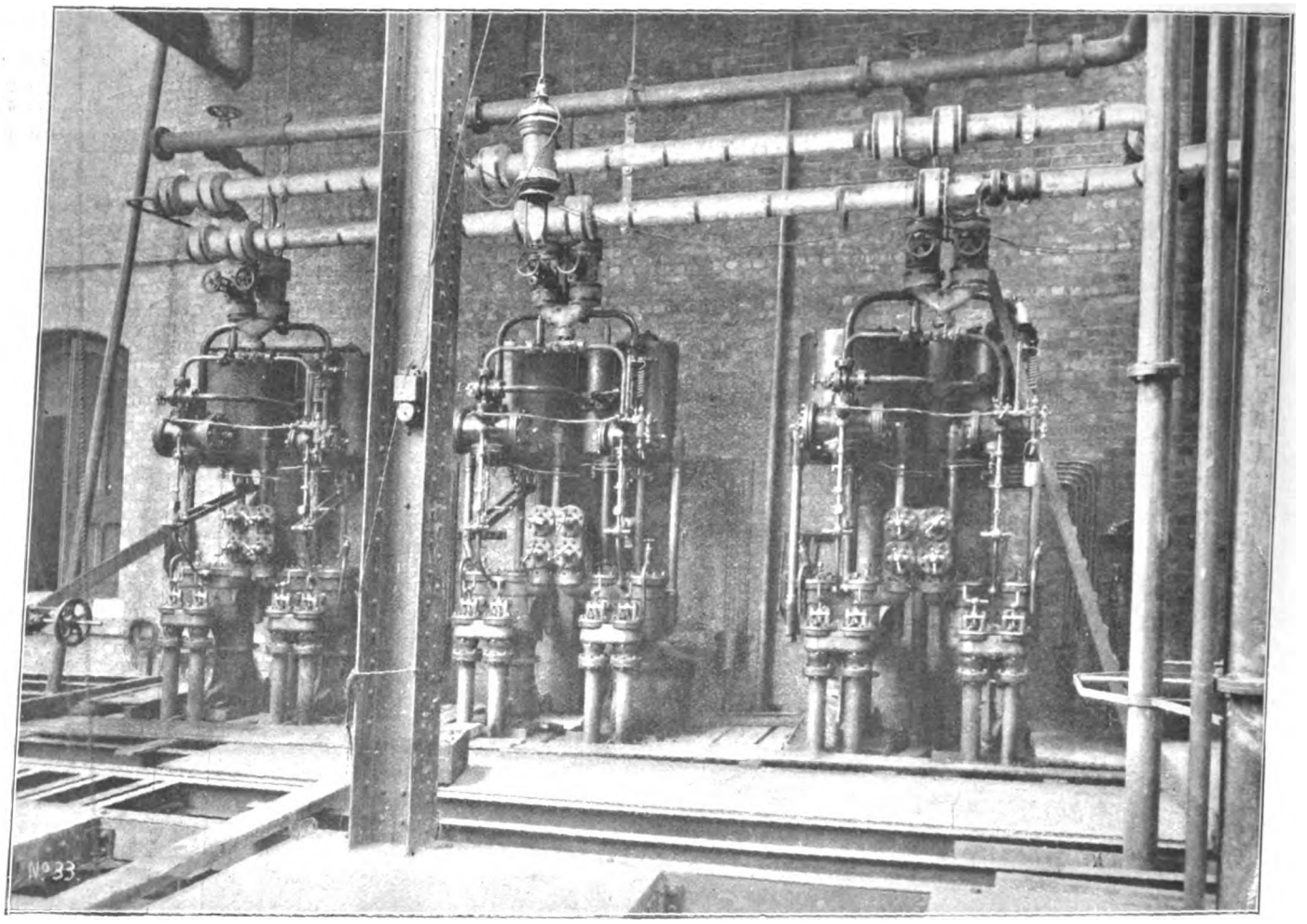
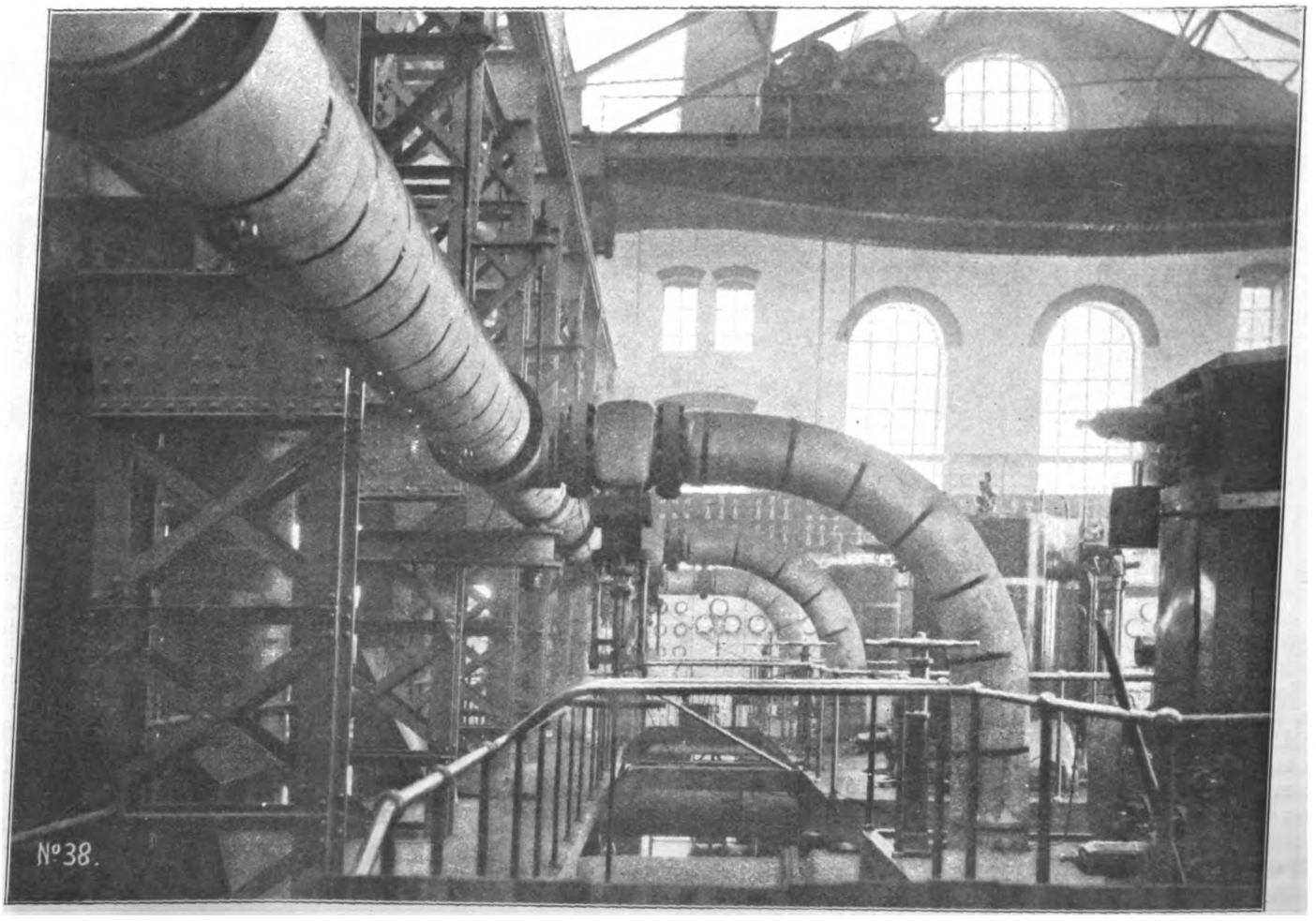


The Manchester Corporation's Electricity Works—The Stuart Street Generating Station.



Pipe Work at the Stuart Street Generating Station.

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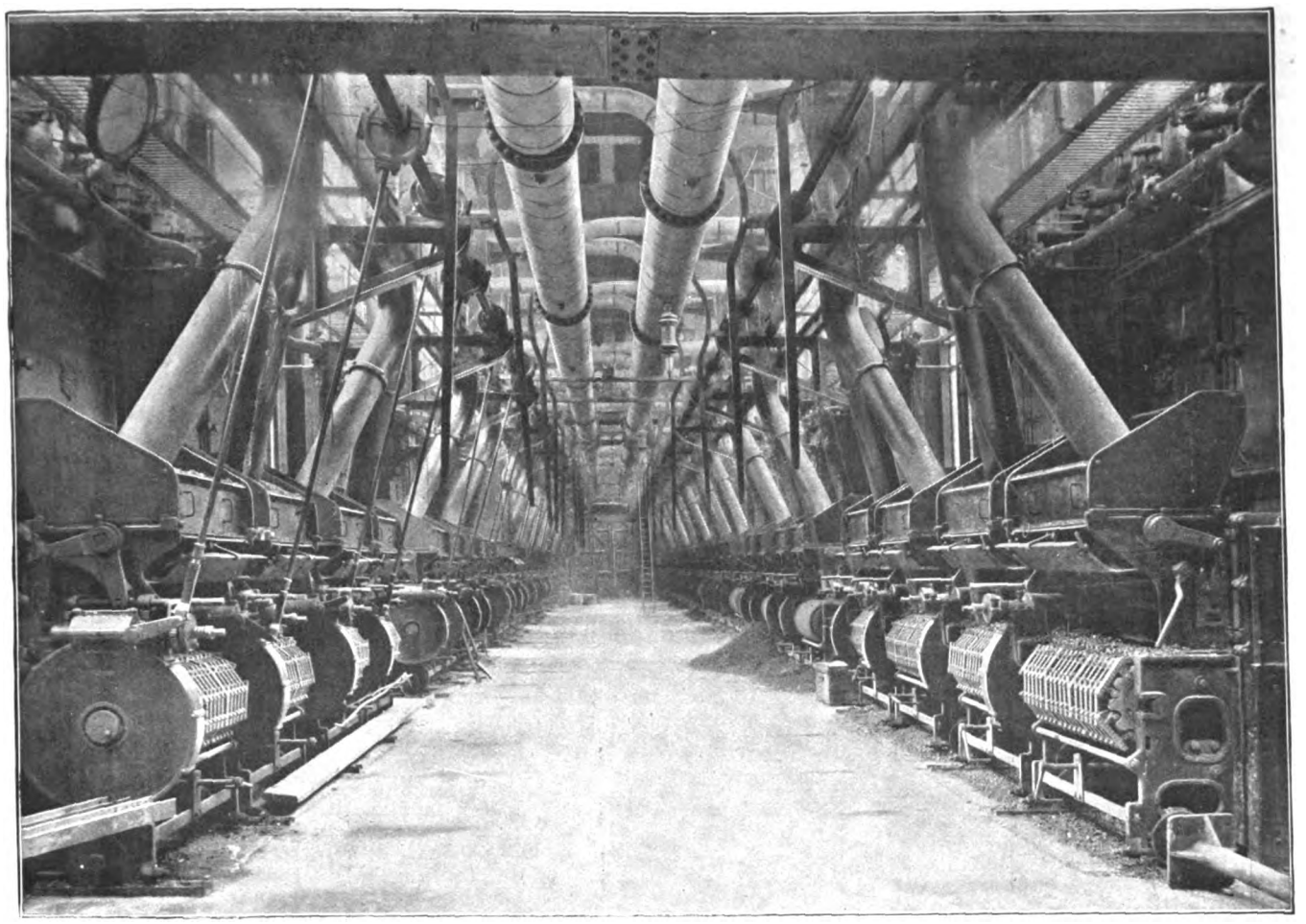

The Boiler House.

arranged in three bays. The boilers are placed in the two side bays; and a centre bay, which is about 23 ft. wide, provides the necessary firing space on floor level, while overhead are placed steel coal bunkers of a capacity of about 1,100 tons. Space is provided above the coal bunkers, and also underneath the firing floor, for two electrically-driven conveyors, which carry the coal to the bunkers from the siding and also take the ashes away from the boilers. There are two chimneys, 200 ft. and 250 ft. in height respectively, the smaller one being 13 ft. 6 ins., and the larger one 18 ft. internal diameter. Both chimneys are lined to a height of 100 ft. with firebrick, and a cast-iron exhaust pipe, 3 ft. diameter, is carried up the centre of the 200-ft. chimney, and a similar pipe, 4 ft. diameter, up the 250-ft. chimney. The 250-ft. chimney is intended to take the gases from the extension boilers, in addition to the boilers included in the 15,000-h.p. installation. The pump room, and also the space required for the feed heaters and the necessary pipework in connection with them, are arranged at the end of the boiler house next to the engine house, and between the two chimneys. Over the pump room is carried a feed tank, to contain about 25,000 gallons of water. The engine house is 114 ft. 5 ins. long and 131 ft. wide, divided into two bays, 53 ft. wide, containing the main generator sets, and the centre bay of 25 ft., which contains the auxiliary and condenser plant, etc.

Astronomical Notes for May.

THE SUN.

ON the 1st, day breaks at 2 h. 3 m. a.m., the Sun rising at 4 h. 35 m. a.m., and setting at 7 h. 19 m. p.m., twilight ceasing at 9 h. 51 m. p.m. The day will, therefore, be $14\frac{3}{4}$ hours in length. After the 26th there is no real night in the latitude of Great Britain, but either daylight or twilight. The Sun's apparent declination at noon on this date will be 14° 48′ 0″, with an hourly variation of 45″.94, his right ascension being 2 h. 30 m. 6 s., the hourly variation of which will amount to $9^{s}.53$.

Sunspot activity seems increasing with unusual rapidity, many spots of varying size having been recently reported by astronomers.

THE MOON.

The Moon's first quarter is reached on the 4th, at 7 h. 26 m. a.m., and she becomes full on the 11th, at 1 h. 18 m. p.m.; last quarter occurs on the 19th, at 3 h. 18 m. p.m., and our satellite will be new again on the 26th, at 10 h. 50 m. p.m. She will be in perigee on the 1st, in apogee on the 16th, and in perigee again on the 28th. When the Moon is at her first quarter she will *set* at 1 h. 5 m. a.m.; at the full she will *rise* at 7 h. 35 m. p.m.; at the time of her last quarter she will *rise* at 0 h. 41 m. a.m.

Two occultations of fifth magnitude stars will occur during the month. The first will be that of the fixed star known as 68 Geminorum, on the 2nd, the disappearance taking place at 7 h. 25 m. p.m. at 86° from the true north point, and the reappearance 1 h. 2 m. subsequently at 301° from the same point. The second occultation is that of χ Ophiuchi, on the 12th, but in this case only the *reappearance* will be visible at Greenwich, the star, and *ex necessitate* the Moon also, being below the horizon at the time of disappearance. The reappearance takes place at 9 h. 5 m. p.m. at 257° from the true north point. Near approaches of γ Sagitarii (variable star), and λ Geminorum (magnitude 3.6), also take place. The former occurs on the 14th, at 3 h. 28 m. a.m., and the latter on the 29th, at 9 h. 5 m. p.m.

The Moon will be in conjunction with Mars on the 7th; Saturn on the 18th; Jupiter on the 21st; Mercury on the 27th; and Venus on the 29th.

THE PLANETS.

Mercury attains his greatest elongation *east* in spring-time on the 10th, when this evasive little planet will be in the position denoted at 2 h. p.m., his distance east of the Sun being then 22°. On the 11th, and contiguous days, he will set about 9 h. 49 m. p.m., or more than 2 hours after the Sun, with an approximate N.D. of 24° 32′, and R.A. of 4 h. 36 m. 1 s., thus taking him beyond the regions of twilight, which will afford a unique opportunity for his observation.

Venus is even more favourably situated than last month, and becomes slowly more satisfactory as a telescopic object, and by the end of the month her disc attains an apparent diameter of 16″.6, and she sets on the 31st at 11 h. 21 m. p.m.

Mars now *souths* early in the evening, and is rapidly deteriorating into a very uninteresting object, the apparent diameter of his disc being but 11″.2, on the 31st.

Jupiter and Saturn are "morning stars," and, therefore, of little interest to the ordinary observer, though the latter planet will rise on the 28th only 3 minutes after midnight.

Uranus is now nearing *opposition*, and it is only his great southern declination which prevents a very favourable situation for the observer.

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On the 31st he will rise at 9 h. 9 m. p.m. with R.A. 17 h. 35 m. 0 s., and S.D. 23° 27′ 53″. He now presents us an apparent disc of 3″.7 diameter.

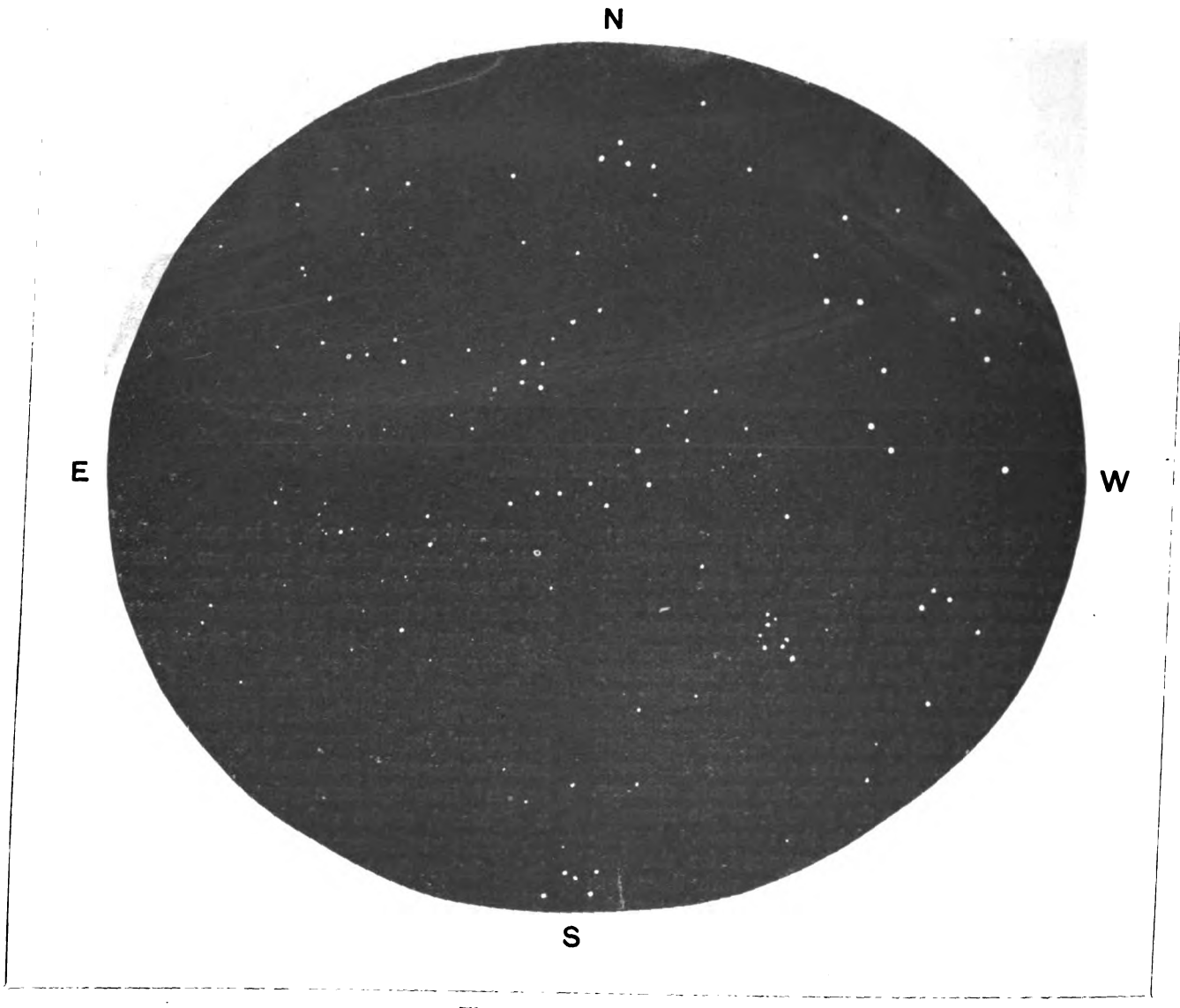
Neptune, for the purposes of the ordinary observer, is practically invisible, and will continue so during the summer months, being in *conjunction* with the Sun on June 26th.

Juno is now at her most favourable position for observation, being in *opposition* to the Sun on May 21st. On the 16th she will rise at 6 h. 48 m. p.m. with R.A. 16 h. 9 m. 43 s., and S.D. 3° 29′ 14″. At, and about this date, this planetoid will be in close proximity to δ and ε Ophiuchi.

THE CONSTELLATIONS.

First turning our gaze towards the south, the constellation which most readily engages the attention is Virgo, not so much from any striking formation in the constellation as a whole, as owing to its conspicuous star, Spica, which will serve as a good point to start from in our survey of the southern sky at this season. Below Virgo is the tail of the "Water Snake," the remainder of the reptile stretching away to the south-westward, whilst above the "Virgin" the "Herdsman" wends his way, with his chief brilliant, Arcturus, the brightest star north of the celestial equator. To the eastward is Hercules, and just to the north of east, Lyra is seen with a star (Vega) almost equally bright to Arcturus. We have now reached the region of the *Galaxy*, or Milky Way, and actually within its boundaries will be found Cygnus, in the north-east. To the westward will be found Leo and the Twins. The map shows the relative positions of the stars at 10 p.m. on May 1st, 9 p.m. in the middle of the month, and 8 p.m. at the end. To better realize the use of the map it should be held above head, face downwards, with S to the south.

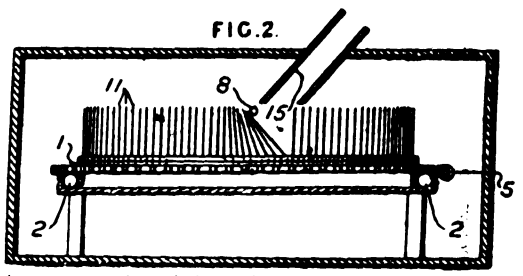
The various constellations can soon be recognised by those acquainted with their form. Near the southern horizon are the four stars forming the constellation *Corvus*. *Scorpio* is down towards the eastern horizon; *Cassiopeiæ*, the five stars together, near the north, Towards the western horizon is the bright star, *Procyon*, to the north of which may be recognised *Castor* and *Pollux*. The *Great Bear* is almost directly overhead in the centre of the map.



The Heavens in May.

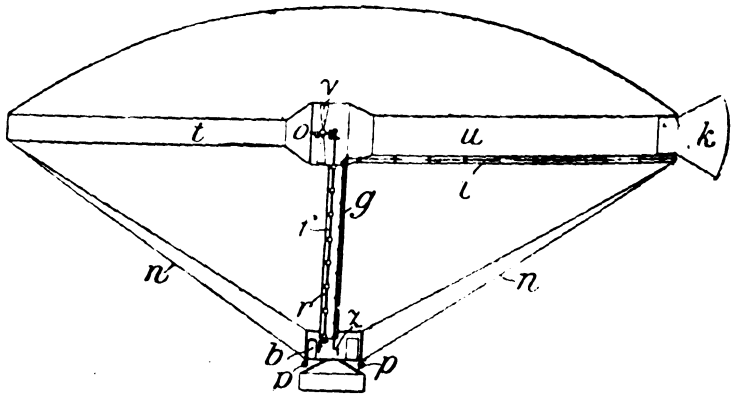
Recent Patents.

24,591. Mutoscopes. GILLETTE, H. P., 751, Powers Block, Rochester, New York, U.S.A. Dec. 3.



A series of vertical cards 11 carrying the pictures are mounted on a horizontal disc 1 turning on ball bearings 2 and driven through a worm and worm-wheel 5. The disc is formed with concentric rings, between which are fixed annular washers engaging the notched edges of the cards. The pictures are viewed through an opening 15, a cross-bar 8 serving to hold back the cards in succession.

245. Aërial Machines. MAWHOOD, H. C. O., 20, Rempart d'Hoboken, Antwerp, Belgium. Jan. 3.



Two tubes *t*, *u* traverse axially an elongated aërostat, and meet at the centre in a chamber *o* containing a screw propeller *v*, which is driven by a motor *b* through a shaft *f* passing through a vertical tube *r*. A rudder *k* at the rear end of the tube *u* is operated through toothed gearing and rods *g*, *i* by a handle *z*. The inclination of the axis is controlled by weights *p* running on cords *n*.

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24,011. Electric telephones, &c. JUSTICE, P. M., 55, Chancery Lane, London.—(*Barton, C. C.; 130, Fulton Street, New York, U.S.A.*) Nov. 26.

FIG.4

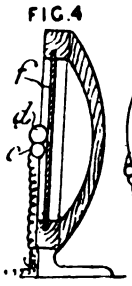
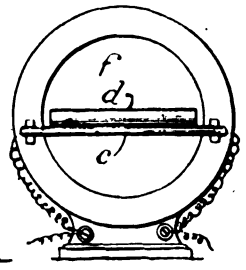


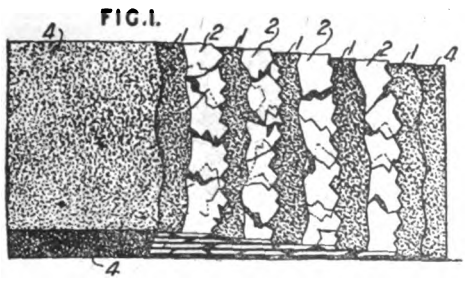
FIG 5



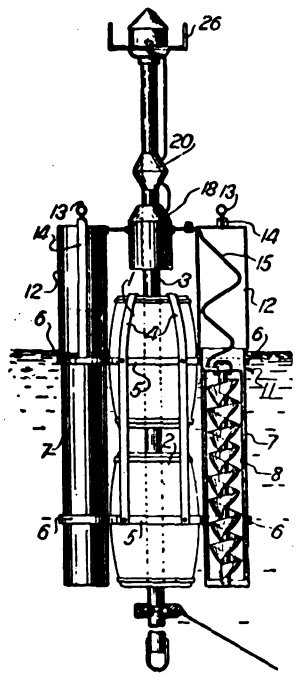
Relates to microphonic apparatus for telephonic and telegraphic use. A transmitter is constructed in which a conductor *c* of low conductivity is included in the circuit, and is mounted, in the case of a telephone, near the diaphragm *f*. A second conductor *d* of higher conductivity rests on or against the conductor *c*, and is vibrated by the diaphragm *f* in the case of a telephone, or is caused to slide by a key or lever in the case of a telegraph transmitter. The conductor *d* may be of graphite or metal, and the conductor *c* is preferably of carbon prepared from plastic masses and having varying resistance throughout its length. The conductors may be upright or horizontal, and the apparatus may be used with or without an induction coil.

24,012. Electric insulating-materials. JAMES, R. W., 1, Queen Victoria Street, London.—(*Mica Insulator Co ; 218, Water Street, New York, U.S.A.*, Nov. 26.

FIG.1.



Relates to the formation of a pliable insulating-material by embedding thin flakes of mica in oxidized oil. Linseed oil is first oxidized, and is preferably mixed with a volatile solvent such as benzine, and gum copal is added. A layer 1 of the oil is rolled out on a frame provided with heating-appliances, and an overlapping layer 2 of thin, preferably primary, mica scales is gently rolled on to the oil. Another layer 1 of the oil is then superposed. Alternating layers of mica and oil may then be added, after which the block is hardened. A jacket 4 of the oil mixture is applied by dipping, and the whole is hung up to oxidize thoroughly. When desired, thin layers of tissue paper may be placed between the outer layers and jacket of the oil More than one jacket may be applied.



24,395. Light Buoys. MÜHLENFELS, R. W. C. VON, 17, Floragatan, Stockholm. Nov. 30.

An acetylene-gas light buoy is shown in the Figure. The gas generators or holders 8 move up and down within the cylindrical vessels 7, which are closed at the tops by the caps 12 secured by the bows 14 and pressed against the frame loops 6 by the screws 13. The carbide is spread along the spiral holders shown, water is admitted by the pipes 11, and the gas generated passes by the flexible pipe 15 to the chambers 18, 20, and to the burner. The chamber 18 contains water, and the chamber 20 cotton-wool. Through the ccops 1, 2, which are filled with cork, the bar 3 is passed. This bar at the lower end carries the ballast, and the rotatable collar for the anchor line. The frame 4, 5, supporting the gas generators, is detachable from the buoy, and is composed of the vertical strips 4, bent inwards at their upper ends, and of the horizontal parts 5 with their loops 6. Transparent colour screens may be supported in the frame 26 around the lantern.

24,332. Ships and Boats. VIDAL, L., St. Romé de Tarn (Aveyron), France. Nov. 29.

FIG.1.

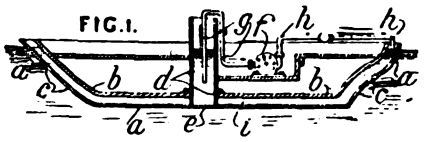
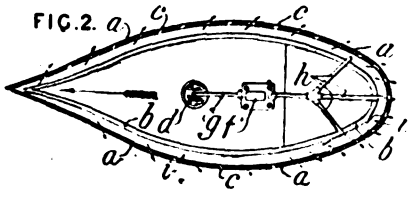


FIG.2.



Propelling and steering by water jets.—Submarine boats, sailing-vessels, ships normally propelled by screw propellers or oars, or other vessels are propelled wholly or partially by water jets emerging from inclined slots *c* in a fixed or removable metal casing *a* surrounding and attached to the hull *b*. Water is pumped into the space *i* by a centrifugal pump *f* having branched outlet pipes *h*. The suction pipe *g* may dip into a hollow shaft *d*, closed at the bottom by a grating *e*, which may be removably retained in position by suspension-rods. The space *i* may be divided into compartments, which can be brought into action separately to facilitate steering.

26,737. Sound-producing. HOPE-JONES, R., Elm Road, Hereford. Dec. 31.

FIG.8.

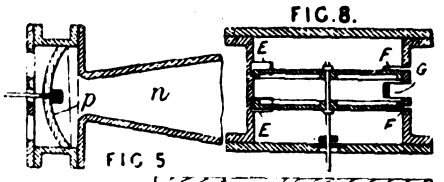


FIG 5

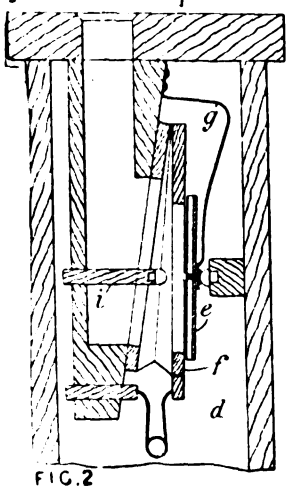


FIG.2

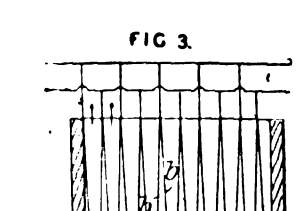
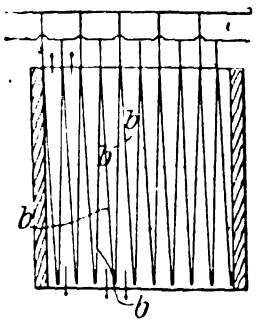


FIG 3.



The invention comprises fluid pressure or electric motors, sound-producing apparatus driven by them and means for controlling the speed of the motor by the periodicity of the musical tone. In the apparatus shown in Fig. 2 the pressure of air in the box *d* closes the bellows *f* until the stop *i* and spring *g* open the valve *e*, allowing some air to escape and the bellows to expand again. Fig 3 shows a number of metal plates *b* fixed at the bottom and there insulated from each other, but touching at the top in pairs; the opposite poles of an alternating current conducted to alternate pairs causes the members to rapidly move apart and come together again, their vibration producing sound. Fig. 5 shows a vibrating piston *p* for the same purpose, this, a thin fine sounding board, or a flexible chamber may be operated by a fluid pressure motor shown in Fig. 8, in which the fluid is admitted between the pistons through the port G. It passes alternately each piston by means of ports E, and ultimately escapes through the exhaust ports F, as the pistons uncover them. The speed of the motor may be regulated by adding a resonator *n* to the sounding-apparatus. A valve between a wind chest and a resonator may be rapidly vibrated by an electromotor. Other motors are described in Specification No. 26,738, A.D. 1901.

FIG.1

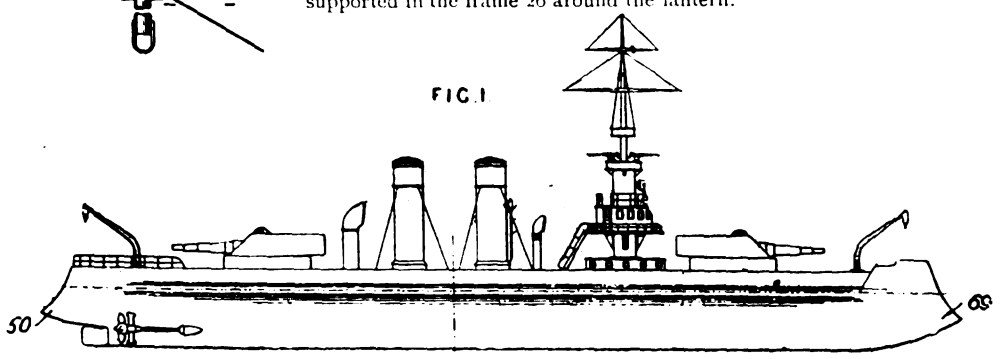
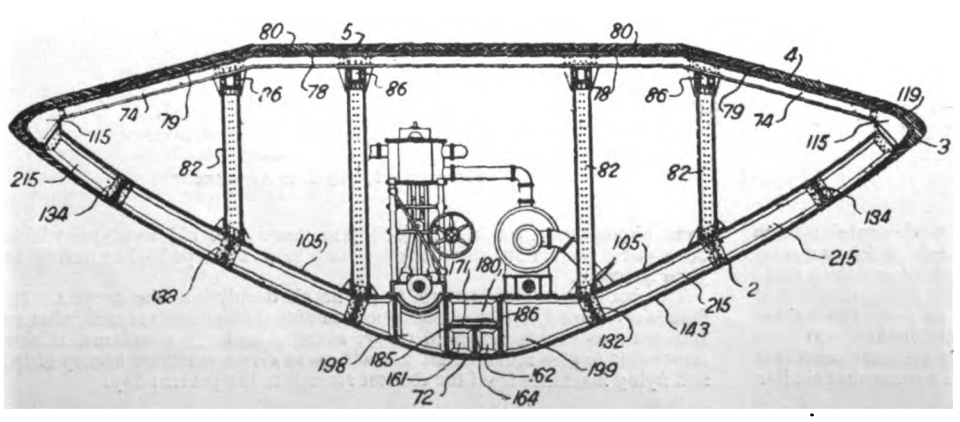


FIG.6



26,334. Ships. COOK, S. G. B., 79, Paul Street, Finsbury, London.—(*Howland-Sherman, C. H.; Washington, Columbia, U.S.A.*) Dec. 24.

Ships' hulls; warships; yachts.—By shaping and constructing the hulls of armoured cruisers and other vessels in the manner shown in the transverse section in Fig. 6, they are rendered practically unsinkable from ramming or collisions, the resistance to propulsion is reduced, the buoyancy is increased, and, in the case of warships, the risk of injury by shot or by submarine attack is minimized. The invention is described and illustrated in connection with an armoured cruiser. The ordinary side and freeboard of the vessel are entirely dispensed with, and replaced by an upwardly and outwardly inclined (preferably parabolic) bottom 2, Fig. 6, connected by curved surfaces 3 to an upwardly and inwardly inclined sea-deck 4 extending to the horizontal or curved central deck 5, which, being much narrower than usual, may be more heavily armour-plated without increasing the aggregate weight. The stern is formed with a ram (Fig. 1) 50 similar in type and function to the ram 69 on the prow.

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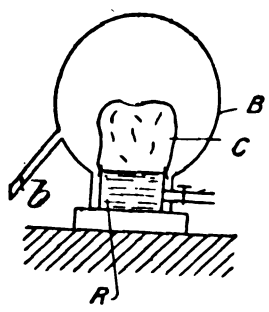
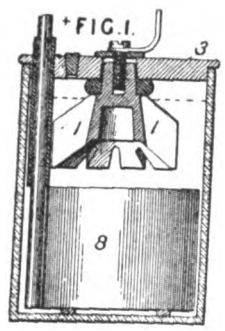
24,414. Raising water by solar heat. BEURRIER, A., Montguyon, Charente Inferieure, France. Nov. 30.

Direct air-pressure apparatus.—Consists of means for utilising solar heat to raise water from a well, &c. Submerged in the water is a closed vessel connected at the top by a pipe *b* to a chamber B of larger capacity. Within the chamber B is a vessel R having an expansible part C, and containing liquid ammonia. The chamber B is placed where it is exposed to variations of temperature, *e.g.*, day and night temperatures, and the bag C is consequently expanded and contracted alternately, and so alternately allows water to enter the submerged vessel and forces it therefrom by a delivery pipe. The inner end of the delivery pipe is fitted with a float-actuated valve which closes before it becomes uncovered, thus preventing the bag C from bursting owing to reduction of pressure on its outside.



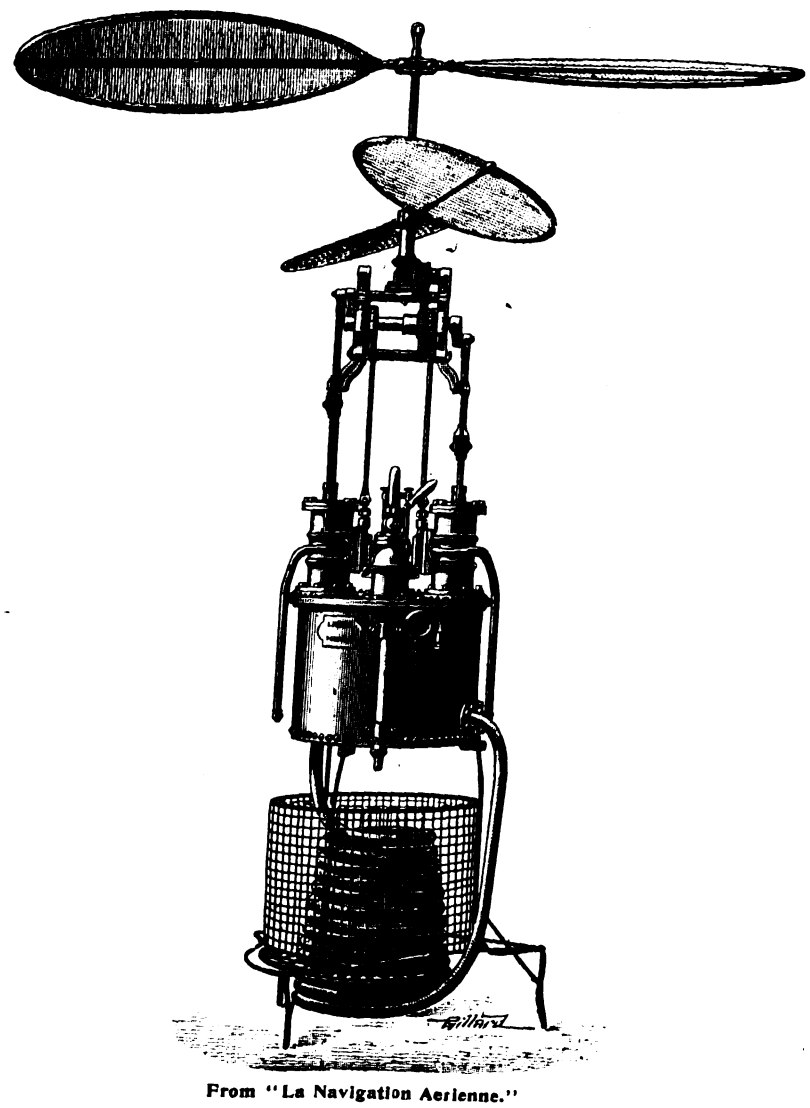


24,627.—Electric Batteries.—D'INFREVILLE, L. M. G. R., 455, Canal Street, New York, U.S.A. Dec. 3.

Primary and secondary batteries.—Relates to a battery in which the electrodes are lead covered with lead peroxide, and zinc, which may be amalgamated, and in which the electrolyte is dilute sulphuric acid. The invention consists in arranging the zinc 1 in the upper part of the solution, and the lead 8 in the lower part of the solution, so that a clear horizontal layer of liquid is left between the electrodes. The zinc may be supported by the cover 3, as shown, and the lead may be of helical, star, or other shape. The lead electrode is preferably of the Planté type.

REVIEWS OF BOOKS.

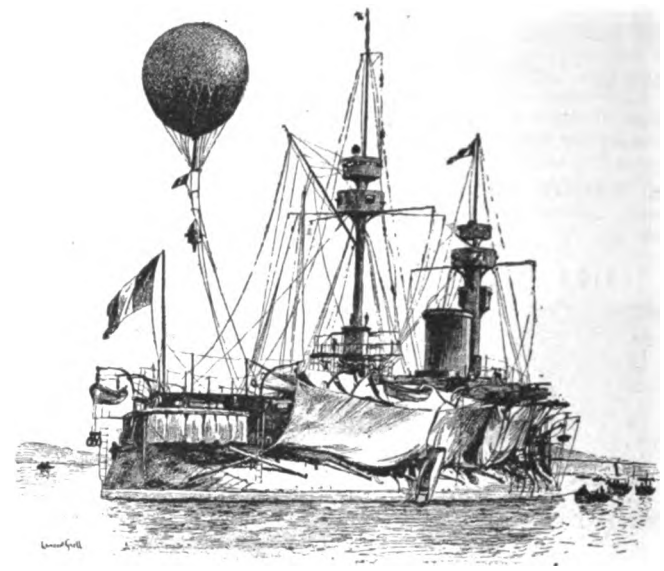
"La Navigation Aerienne," by J. Lecornu (Nony et Cie., Paris). The subject of the navigation of the air has certainly come very much to the fore of late years. We referred a few months ago to the comparatively large number of books that have been published during the last year, and now one more has been added to the list, and one which eclipses all its predecessors, in size,



From "La Navigation Aerienne."

number of illustrations, and in style; for M. Lecornu's work contains some 480 large pages, and includes no less than 360 illustrations. It forms a most complete history of the whole subject from the earliest legends of antiquity up to the balloon of Lebaudy, now undergoing its trials, and the flying machine of Hoffmann, which is still in course of construction. Some 40 years ago a great work was published in England, entitled, "Astra Castra," dealing with the subject. Since then a vast amount has been accomplished in all branches of this study of aërial locomotion, and the book now before us forms a somewhat similar and up-to-date version of that work, omitting, however, the extraordinary and eccentric additions of poetry and religion with which the older book was freely interspersed.

In criticizing the few points on which we should like to have seen a difference, we must point out one fault, very common to books dealing with this subject, which is the illustration and description of certain devices which never progressed further than the fertile and certainly illogical minds of their designers. Such descriptions can do but little good and only fill up space which might be devoted to more instructive examples. This book also reproduces a good many characters, which, though of some slight interest as illustrating public feeling on the matter, are hardly worth the space devoted to them.

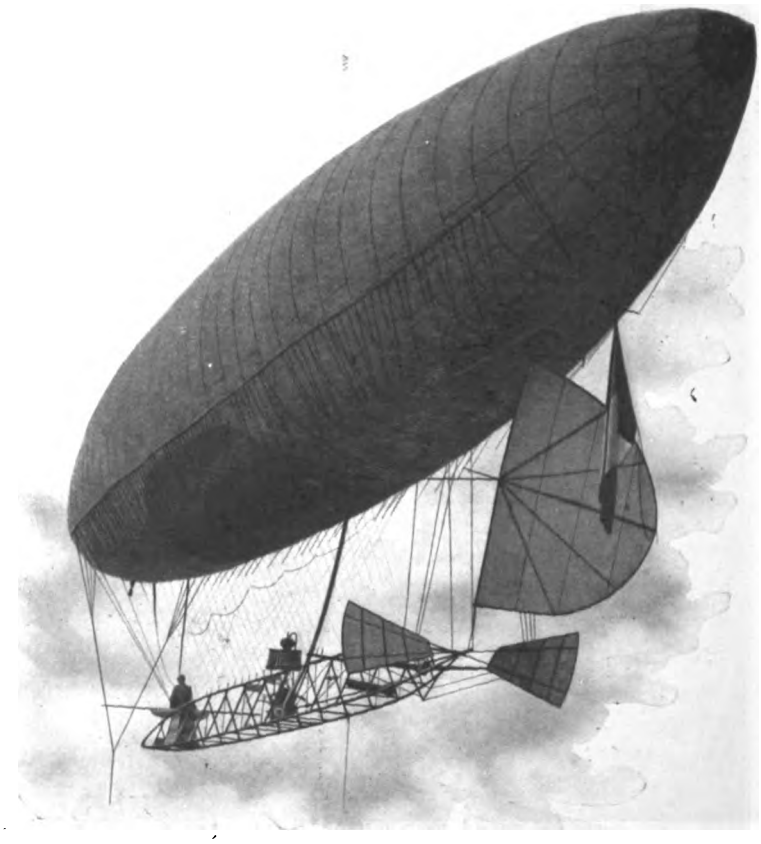


From "La Navigation Aerienne."

Errors, of course, are bound to creep into a work of this nature and magnitude, and we can quite realize the difficulties of attempting to collect information on inventions and systems, many of which have been purposely kept more or less secret, and many having been brought out in foreign lands. As an instance, we note that in referring to British war balloons, the author speaks of a gigantic kite attached to a captive balloon to support the latter in strong winds, adding that it is the invention of "Captain Douglas." This, presumably, refers to an experiment made by Mr. Douglas Archibald, many years ago, before any organized military balloon establishment existed.

There are omissions too. We have failed to find any reference to the promising experiments of Pilcher, who gave up his life in the cause, or to his successors in this line of experimentation, the brothers Wright.

The illustrations vary a good deal, some few being very creditable reproductions from photographs, but the majority are merely the old woodcuts which hav done good service in other books which have been published during the las 30 or 40 years.



From "La Navigation Aerienne."

The book does not pretend to go at all deeply into the subject. But few figures are quoted, and the descriptions of actual machines are somewhat meagre. But with so vast a range to cover, even in so large a volume, it would be impossible to give much detail as well as to give a complete history of balloons and flying machines from the earliest records to the present day.

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"Transactions of the City of London Entomological and Natural History Society," 2s., is a little volume forming a valuable and interesting addition to the literature on the subjects covered. After the Presidential Address by Mr. L. B. Prout, F.E S., follow a series of some half dozen papers on Entomology. Mr. Sich's paper on *Phyllocnistis Suffusella*, is particularly complete, and many new facts are brought to light. The Society has its rooms in the London Institution, Finsbury Circus.

"The Scientific Memoirs of Thomas Henry Huxley" edited by Sir Michae Foster and Professor E. Ray Lankester, are to be completed by the publication of a supplementary volume of under 100 pages, which Messrs. Macmillan and Co. have nearly ready. It contains the completion of Huxley's "Survey Memoir" on fossil fishes, and also three essays of considerable interest to zoologists which are not contained in the published edition of the more general works.

Professor Harry C. Jones's important treatise on **Inorganic Chemistry** aims chiefly at introducing physical and physico-chemical conceptions into the chemistry taught to students. The laws of electrolytic dissociation, and of mass action, the phase rule, and other newly-discovered generalizations are here added to those older generalizations on which inorganic chemistry has previously been built. And, further, elementary mathematics are employed in the work of exposition.

Dr. G. S. Fraps, of the North Carolina College of Agriculture and Mechanic Arts, is the author of a treatise on **Principles of Dyeing** which is published by the Macmillan Co. The work attempts to apply to the teaching of dyeing the same methods of class-room work, co-ordinated with experiments in the laboratory, which have proved so successful in the teaching of inorganic chemistry and other branches of science. It is intended primarily for the student, but it is hoped that the book may also prove of benefit to the practical dyer who desires a fuller knowledge of the principles underlying his art.

"The Role of Diffusion and Osmotic Pressure in Plants," by Burton E. Livingston. The University of Chicago Decennial Publications, Second Series, Vol. VIII., pp., 144, 8vo, cloth; net, $1·50; postpaid, $1·60. The University of Chicago Press, Chicago, Illinois.—The subject of osmotic pressure has recently become a very important one in physiology. On the animal side, the work of Loeb and others has pointed out that the osmotic pressure of the liquid in which organisms are growing often determines, in a large measure, how they will grow and what form they will take. With plants the same is true, as has been conclusively shown by the experiments of the author with lower forms. Diffusion through membranes is also of great and increasing interest from the standpoint of physiology. All of the complex phenomena of respiration and assimilation depend upon this process. This is true in both animals and plants, but is especially so in plants, where the absence of the circulatory system of animals makes diffusion doubly important. Thus, this volume fills a need felt by students of both branches of physiology. The discussion is always from the standpoint of plant life, but where evidence from the animal side is needed it is brought in. The first part deals with a clear statement of the physical principles of diffusion and osmotic pressure, and will probably be found of use to beginners in physical chemistry and theoretical physics. The second part presents the literature of the physiological *rôle* of these factors in a connected and readable form, and embodies the researches of the author as to the influence of the medium. Not the least valuable part of the work are the citations, which are very complete and copious, so that the reader is at once put in direct contact with the literature of the subject. The citations are made by footnotes, and are, therefore, in the most convenient form.

"Photographic Lenses," by Conrad Beck and Herbert Andrews (R. & J. Beck), 1s, is a "simple treatise" but one going very fully into the subject. Though, not unnaturally, having as its main object the laudation of the Beck lenses, this book gives a very clear idea of all matters pertaining to the photographic lens, its function, its manufacture, corrections necessary or desirable, its properties, its variations and types and its practical application. It is fully illustrated, and is well worth the study of those who wish to understand this somewhat intricate subject without going too deeply into the technicalities of it.

The Rev. F. C. Stebbing has prepared for Messrs. Macmillan a second edition of his treatise on *Navigation and Nautical Astronomy*, which will be published shortly.

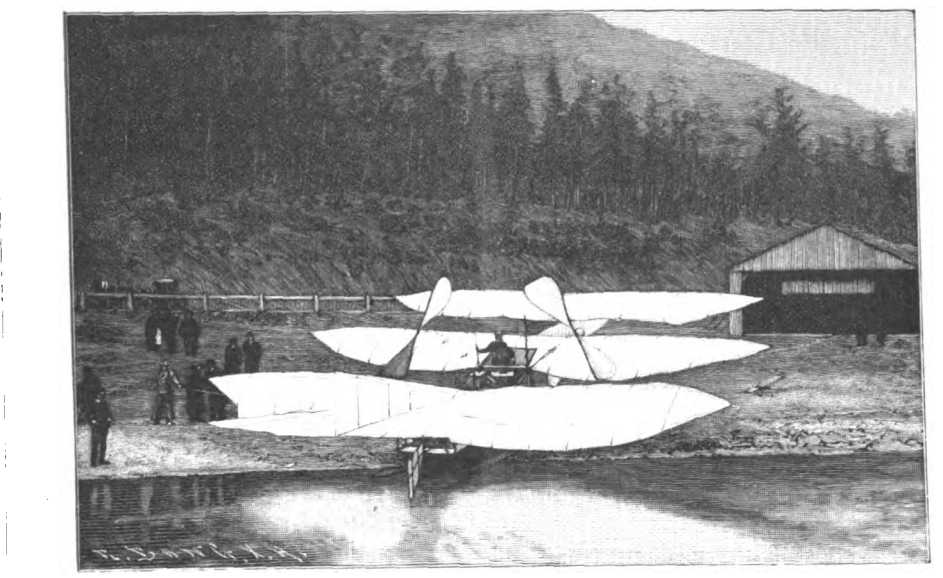
The "intermediate" volume of Mr. Vincent Murchè's *Globe Geography Readers* is a series of lessons on the geography of the British Islands, furnishing easy topographical and historical descriptions which a·e fully illustrated.

Action of Gelatine upon Glass.

In a paper read before the Academie des Sciences M. Cailletet describes the action of gelatine upon glass and other surfaces. When a glass object is covered with a thick layer of strong glue, the latter adheres strongly when wet, but upon drying it may be detached and carries with it glass scales of different thicknesses which have been lifted from the surface. The glass which is thus treated presents a surface whose designs resemble those of frost on a window-pane, and have a decorative effect.

M. Cailletet made experiments with gelatine upon different substances, and found that tempered glass was easily attacked, as well as Iceland spar, polished marble, fluorspar, and other bodies. A sample of quartz cut parallel to the axis of the crystal was covered with two layers of fish-glue; after drying it was found that the surface was attacked and showed a series of striæ which were parallel, rectilinear, and ran close together, while in the case of glass the striæ were curved. When certain salts were dissolved in the gelatine, namely, those which were easily crystallized and had no action, there was produced on the glass a series of engraved designs which had a crystalline appearance. Thus a solution of strong glue containing 6 per cent. of alum gave very fine designs somewhat resembling moss in appearance; other salts such as hyposulphite of soda, nitrate and chlorate of potash, will produce analogous forms.

M. Cailletet told of the strong mechanical action exerted by a layer of gelatine when drying. If a sheet of cardboard, lead or even wire gauze is covered with a gelatine solution, the surfaces are seen to curve into the form of a cylinder as the gelatine contracts. Upon thin glass the effect is striking; when a layer of strong glue is spread upon a cylindrical vessel of thin glass the effort which it exerts when drying is sufficient to break the vessel with explosion. When a plate of thick glass covered with gelatine is examined by polarized light a powerful mechanical strain is observed in the glass, and the value of this effect could no doubt be measured.



From "La Navigation Aerienne."

Platinum Waste.

THE disintegration of electrically-heated platinum and kindred metals in air puts a formidable difficulty in the way of their utilisation for heating purposes. This is especially the case with iridium, which is otherwise the most suitable metal on account of its high melting point. With a view to meeting these difficulties, L. Holborn and L. Austin, whose paper is summarised in the *Electrician* by M. Fournier d'Albe, have made some measurements with the various metals at different pressures and temperatures and in various gases. These experiments brought out a characteristic difference between palladium and the other metals. The disintegration of palladium varies greatly with the pressure, but not with the nature of the gas. In platinum, iridium, and rhodium, the reverse is the case. Thus, a sheet of platinum 1mm. wide, 0.1mm. thick, and 75mm. long, loses 0.68 milligramme in half-an-hour in open air when heated to 1,500 degs., whereas in oxygen it loses 3.41 milligrammes, and in nitrogen 0.05 milligramme under the same conditions. In rhodium the loss is about half that in platinum, but in iridium it is about 20 times as great. Palladium heated to 1,350 degs. loses 1 milligramme in open air or nitrogen, but the loss becomes 7.3 milligrammes on reducing the pressure to 25mm. The authors suppose that palladium undergoes sublimation, while the other metals are subjected to some kind of chemical action.

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Prize Competition

WE regret that the arrangements which we suggested for the alteration of the competition, by winding up the present one and starting afresh, have not met with unanimous approval, though most of the competitors have met our suggestions in a favourable and conciliatory spirit. One competitor still maintains his claim to compete for the £100. Under these circumstances we cannot do otherwise than continue the competition, but have made certain alterations in the rules, to which we hope competitors will agree. Should any have objections to these, we should feel much obliged if they would kindly fully state their objections and suggest a means of overcoming the difficulty.

It may be noticed that the principal additions are—that the same fancy name must be adhered to; that only two solutions of one problem are allowable; and that, in order to give more time both to the solvers and to the judges, the solutions need in future only be sent in one month after the problem is published.

The competitor gaining the greatest amount of marks each month will be awarded the monthly prize of ONE GUINEA. But in order to encourage clever inventors, and not merely reward those who may happen to hit upon a happy idea, a GRAND PRIZE OF **ONE HUNDRED POUNDS** will be awarded—after twelve problems have been sent—to that inventor who shall have gained the greatest aggregate of marks during that period, provided he shall have gained at least *30 per cent. of the full marks* in at least six of the competitions (whether he has gained a monthly prize or not).

RULES.

1. Designs to be sent in to the office before the end of the current month, accompanied by the coupon cut from this paper.
2. The solutions sent in must be concise, yet fully descriptive of the idea intended. To comply with this they must not exceed 300 words, and not more than two simple diagrams should accompany it.
3. Solutions will be published as considered desirable by the editor.
4. Competitors may obtain patent rights for their ideas, but they must run all risk of the publication in this paper interfering with the obtaining of such rights.
5. Competitors may send in their designs under a fancy name for publication, but their true names and addresses must be inserted on the coupon, which, in the event of their winning a prize, will be published. The same fancy name must be adhered to throughout in future.
6. The same person may send in two solutions so long as a separate coupon accompanies each. All marks so gained will count for the grand prize, but the monthly prize will only be awarded for the one best solution. If the two solutions appear to the judge to be but slight variations of the same invention, marks will be deducted from the second solution.
7. Novelty of design is not a *sina qua non* (since this would be extremely difficult to prove), but only the person sending a description with the coupon is entitled to reward.
8. It would add to the value if a statement be added to say if the design has been practically tried; but to corroborate this the inventor may be called upon to give a demonstration before receiving a prize.
9. In the event of an equality of marks or any other exceptional circumstances, the proprietor will decide on the fairest method of distributing the prize.
10. Non-compliance with the above rules may disqualify a competitor.

The following is a Complete List of Competitors and the marks gained by them to date:—

	Marks.		Marks.
C. L. Walker (under different names)	441	Q. E. D.	99
Kass	*434	Gunner	95
R. Fenton	428	Slide Rule	83
E. M. F.	409	P. Spencer	80
A C. T. (and other names) ..	318	F. Kowachi	67
K O. H.	300	Cap	65
L. R. Connor	296	Alarm	65
Cantab	280	Aeneas	60
Second West	244	Thermo	60
Kharki	214	W. E. Knowles	45
Hardstaff	205	H. P. Legge	40
Humber	202	Science	35
C. Burrage	182	P. L. Preston	30
Bacilligraph	159	Molten Diamond	20
R. J. M.	105	Farranight	15
Fred	101	X. Z.	15
		R. Warren	10

(* Including 50 liable to disqualification, Dec., 1902.)

If any errors occur in the above list, we should be glad to have them pointed out, otherwise we shall adhere to these figures.

The subject for this month will be—

PHOTOGRAPHY IN COLOURS

By any novel method.

The Illustrated Scientific News.

The following Articles by well-known authorities have appeared in the "I. S. N."—

Scientific Anecdote - -	PROF. H. H. TURNER, F.R.S., Pres. R. Ast. Soc., Sav. Prof. Ast, Oxford.	Nov. 1902.
The de Bradsky Airship -	MAJOR BADEN-POWELL, Scots Guards. Pres. Aëronautical Soc.	Nov. 1902.
The Greatest Flying Creature	Ditto.	Jan. 1903.
The Invisible Universe -	SIR ROBERT BALL, LL.D. F.R.S.	Dec. 1902.
Earliest Human Likeness -	HON. AUBERON HERBERT, D.C.L.	Feb. 1903.
Incandescence Electric Lamp	DR. J. A. FLEMING, F.R.S.	Feb. 1903.
Gliding Machines - -	O. CHANUTE, ESQ., C.E., Late Pres. American Soc. of Civil Engineers.	Feb. 1903.
Coherers - - - -	ROLLO APPLEYARD, ESQ., A.M. Inst. C.E.	Mar. 1903.
Silica Glass - - -	W. A. SHENSTONE, F.R.S.	April 1903.
Wireless Telegraphy - -	E. S. GREW, B.A.	April 1903.
The Nile Dams - - -	Ditto	
Life from Other Worlds -	PROF. G. H. BRYAN, Sc.D., F.R.S.	April 1903.

Important Illustrated Articles have also been contributed anonymously on—

Range Finders - - - - - -	Oct. 1902.
Sounding the Atmosphere - - - -	Nov. 1902.
Round Houses - - - - - -	Jan. 1903.
Automatic Telephone Exchange - - -	Jan. 1903.
Marine Steam Turbine - - - - -	Jan. 1903.
Trans-Atlantic Wireless Telegraphy - -	Feb. 1903
Hydraulic Mining - - - - - -	Feb. 1903.
Aims of Bacteriology - - - - -	Feb. 1903.
Renovation of Bad Air - - - - -	Feb. 1903.
Nernst and Cooper-Hewitt Electric Lamps -	Mar. 1903.
Railway in the Air - - - - -	Mar. 1903.
Pendulum Propeller - - - - -	Mar. 1903.
Constituents of the Atom - - - -	Mar. 1903.
Splash of a Projectile - - - - -	Mar. 1903.
Projectiles and Armour Plates - - -	Apr. 1903.
Higher Education and Research:	
I. **University College, London** - -	Mar. 1903.
II. **King's College, London** - - -	Apr. 1903.

Full page Portraits and Biographical Notes of—

1. **Sir William Huggins.**	*Pres. Royal Soc.* -	Oct. 1902.
2. **Lord Kelvin** - - - - - -		Nov. 1902.
3. **Sir William Crookes** - - - -		Jan. 1903.

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THE ILLUSTRATED

Scientific News.

A Monthly Journal devoted to Popular Science.

VOL. I. NO. 9. [Entered at Stationers' Hall.] JUNE, 1903. SIXPENCE. By Post, 7½d.

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Lyginodendron:

A Seed-Bearing Fern from the Coal Measures.

BY PROF. F. W. OLIVER.

AMONG the best-known fossils of the Coal Measures may be reckoned the impressions of Fern-fronds, often met with in a most beautiful state of preservation. These specimens are of value to the botanist as giving him indications of the habit of growth of the plants of the carboniferous period, but for a knowledge of their internal structure he must rely upon petrifactions, specimens, that is to say, which have become embedded in and preserved by some inorganic agent like carbonate of lime or silicic acid, and which can be cut and ground into the thinnest sections and examined microscopically. It sometimes happens that a plant is known to us both from impressions and petrifactions too; when this is the case, as with the plant which forms the subject of this article, our sources of information concerning that plant are nearly as good as if we possessed dried herbarium specimens and fragments of its various organs preserved in spirit.

But to return to the Fern-fronds. A number of these have been found with indications of fructification upon them, clusters of sporangia, entirely confirming the view that the fronds really belonged to Ferns in the sense in which the term is used now-a-days. But besides these there are others which are always sterile, and this character long ago attracted attention and became a matter of comment. It was conjectured that these fronds might not belong to real Ferns at all, but to plants having some other method of reproduction.

With the fuller knowledge gained from detailed examination of petrifactions it has become generally recognised that a number of Coal Measure plants, having the outward form and appearance of Ferns, differed from true Ferns in several important structural characters, and, indeed, showed an approach to the Cycads, a primitive but still existing group of seed-bearing plants. These forms, which include *Heterangium*, *Lyginodendron*, *Medullosa*, and other genera, constitute the group which has been conveniently named Cycadofilices, in recognition of their transitional characters. But whether the fructification was also seed-like, or, on the other hand, was still that of typical Ferns, has remained unknown till a few months ago. It now appears from a study of certain detached Coal Measure seeds that have come under the observation of Dr. D. H. Scott, F.R.S., and the present writer, that *Lyginodendron*, one of the commonest, best-known and best preserved of the Cycadofilices, was actually a seed-bearing plant, a Fern which bore seeds.

The history of *Lyginodendron* is not without interest, and may be briefly recalled. So long ago as 1866 Binney—one of the fathers of Fossil-Botany in this country—described fragments of its stem showing structure, and named it *Dadoxylon Oldhamium*. Three years later, Williamson, recognising that its wood was not that of a Conifer, proposed the name of *Dictyoxylon*; but in 1872, feeling sure that these stems must be identical with those to which were due certain sandstone

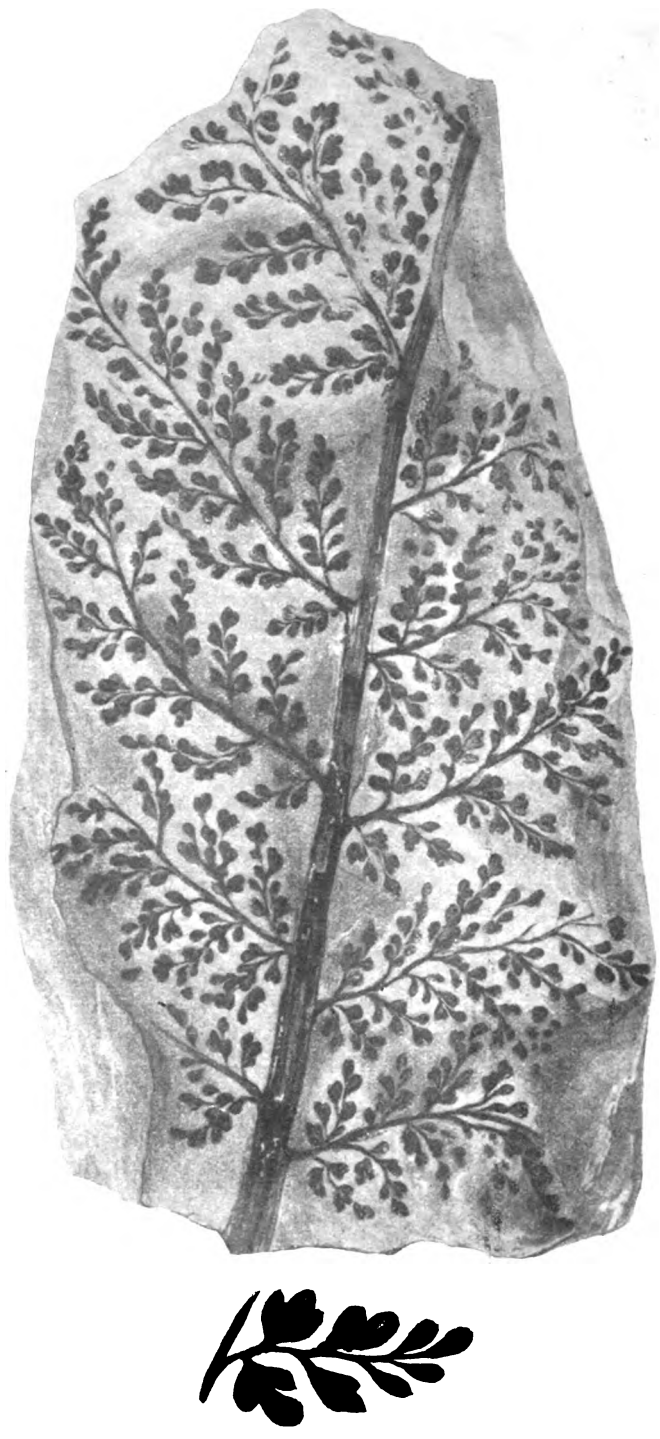

Fig. 1.—Impression of portion of frond "Sphenopteris Hœninghausi." The leaf of "Lyginodendron"—natural size.

impressions figured by Gourlie in 1843 and named by him *Lyginodendron* (from the basket-like marking of its surface), Williamson adopted this name as it had priority to his own. Thus, these stems became known as *Lyginodendron Oldhamium*. At the same time Williamson announced the discovery of a new leaf-stalk for which he proposed the name of *Edraxylon*, although he suspected it to belong to *Lyginodendron*. In 1874 it was fully described under the name *Rachiopteris aspera*, *Edraxylon* being withdrawn—the generic name being that

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employed for unallotted fern-leaf petioles, the specific name *aspera* in recognition of the numerous sharp outgrowths or emergences which arise from its surface. Indeed, it was the presence of these emergences which are found on both stem and leaf that suggested these structures were really parts of the same plant. In the same paper Williamson showed that the Fern-frond, known in the state of an impression as *Sphenopteris Hœninghausi* (reproduced here in the first figure), really belonged to the petiole *Rachiopteris aspera*, and thus probably represented the foliage of *Lyginodendron*. Full corroboration of Williamson's attribution was established in 1890, when petrifactions came to hand, showing continuity between stem and leaf. The roots, meanwhile, had been described as independent structures in 1876, under

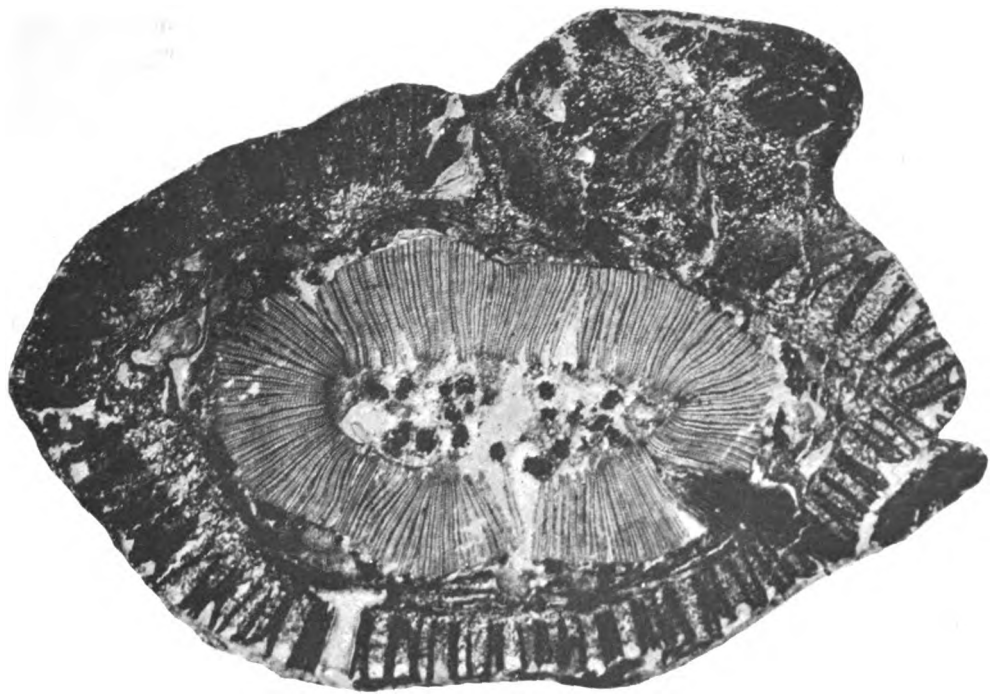

Fig. 2.—Transverse section of stem of "Lyginodendron"—magnified.

the name of *Kaloxylon Hookeri*, but it was only some twenty years later that they were recognised as belonging to *Lyginodendron*.

In this way, piece-meal, the dismembered body of *Lyginodendron* was reconstituted, and in 1896 a full account of the structure of the vegetative organs was published by Williamson and Scott, working in conjunction. The result is that we possess a fuller knowledge of this fossil than of any other plant from the Coal Measures, and, indeed, than of a great many recent plants, too, for the matter of that.

Lyginodendron was, in habit, a small tree-fern with slender stem, and much-divided fronds. From the stem, which, perhaps, scrambled over the neighbouring vegetation, thin aërial roots grew down into the soil. As regards its internal organisation, the leaves were wholly fern-like; the stem, which hardly ever branched, showed an approach to Cycads in two particulars. The vascular strands or bundles which surround the pith, and ultimately pass out from the stem and constitute the vascular supply of the leaves, have a peculiarity (they are mesarch) met with in recent plants in the leaf-bundles of Cycads only. This is a very striking point of resemblance. Further, there is present around the primary ring of bundles a broad zone of secondary wood (a prominent feature in the adjacent photograph of a transverse section), which, in structure, closely resembles that of Cycads. In other respects the stem is still fern-like, and recalls that of such a recent Fern as *Osmunda*. The roots, too, are fern-like in their primary structure, gymnospermous in their secondary thickening.

Sufficient has been said to justify the assertion that, on its vegetative characters *Lyginodendron* shows a decided approach to the Cycads without having abandoned its fern-like habit. The other Cycadofilices resemble it in being transitional types, though some, like *Hetcrangium*, are even more fern-like, whilst others approach the Cycads more nearly.

In view of these characters it was impossible to say whether *Lyginodendron* would turn out to be a Fern or a Gymnosperm in its reproductive methods, though I am profoundly convinced that Dr. Scott has held the latter alternative as probable all along!

Last winter, however, detached seeds belonging to Williamson's genus *Lagenostoma* came under our joint observation. Hitherto there had been described two species of *Lagenostoma*, *i.e.*, *L. ovoides* (of which a longitudinal section is illustrated here), and another very peculiar form known as *L. physoides*. The seeds which fell into our hands are undescribed, but bear Williamson's manuscript name of *Lagenostoma Lomaxi*, after Mr. J. Lomax, the well-known collector and petrologist of Bolton. *L. Lomaxi* is a tiny seed, 5½ millimetres high and 4¼ mm. in diameter, in shape like a Jaffa orange. It differs in no essential character from *L. ovoides*, which is figured here. In structure it is a complicated seed, as Coal Measure seeds go. The bottle-shaped body at the apex is the pollen-chamber, and here, into a bell-shaped crevice, were received the pollen-grains. Around the pollen-chamber is a structure quite unique, which has received the name of "canopy." This is a sort of dome—perforated above where the top of the pollen-chamber gains access to the exterior. The canopy is fluted within, and consists of nine chambers symmetrically arranged around the central opening or micropyle. If nine tentacles be imagined surrounding the top of the seed all welded together into a continuous "canopy," some idea of the nature and complexity of this seed may be obtained. But no detailed description of the seed itself is possible within the limits of this article. Suffice to say, it is as much a seed as are any of the seeds found in the Palæozoic Rocks, whilst in its details it is both complicated and instructive.

Had these seeds been detached in the way that is so provokingly usual with *Lagenostoma* and the other seeds of this period, it would have been impossible to trace them to the plant that bore them. For, as a rule, the seeds are cut off clean by a layer of separation at their insertion, like a falling leaf in autumn. However, these specimens of *L. Lomaxi*, no doubt torn from the plant before the layer of separation became effective, had short stalks, and just at the level at which the seed was inserted on its stalk was an envelope or cupule, which formed a loose enclosure to the seed, reaching up beyond the micropyle in young specimens. The relation of the seed to its cupule may be compared to that of a hazel-nut to its husk—of course, in miniature. The cupule was ribbed below and irregularly lobed or cut into segments above; but the feature of chief importance was the presence of numerous capitate glands, some stalked, some sessile, on stalk and cupule. It was these capitate glands, which resemble the emergences found on the stem and leaf of *Lyginodendron*, that first indicated the probability that this seed might belong to that plant. Their state of preservation was peculiar, but a full examination of the vegetative organs showed that the glandular emergences, which are so characteristic of *Lyginodendron*, occurred sometimes in precisely the same state of preservation, whilst in form, size, and structure there is the most complete agreement.

There is no other known plant from the Coal Measures with glands at all similar to those described, nor is it likely that any unknown Gymnosperm should so exactly resemble *Lyginodendron* in these characters. On the ground, then, of the glandular structure, the conclusion was drawn that the seed *Lagenostoma Lomaxi* can have belonged to no other plant than *Lyginodendron Oldhamium*, and more particularly to the glandular form of that type with which the seed is associated.

The cupule round the seed was probably an effective organ during the early stages of development, and this would account for its disorganised state in the older specimens that passed through our hands.

The details of the structure of the cupule and stalk confirm the view based on the glands. The vascular bundle which traverses the stalk agrees with a bundle from one of the smaller petioles of *Lyginodendron*, and there are other corroborating points. Hence, though the seeds have not been found *in situ*, it would seem probable they were borne on the leaves, and sooner or later it may be expected that impressions of the leaves (*Sphenopteris Hœninghausi*) will come to hand showing traces of the seeds.

It thus appears that in a fern-like plant the seed habit had been fully attained. Nor is it likely that *Lyginodendron* stood alone in this

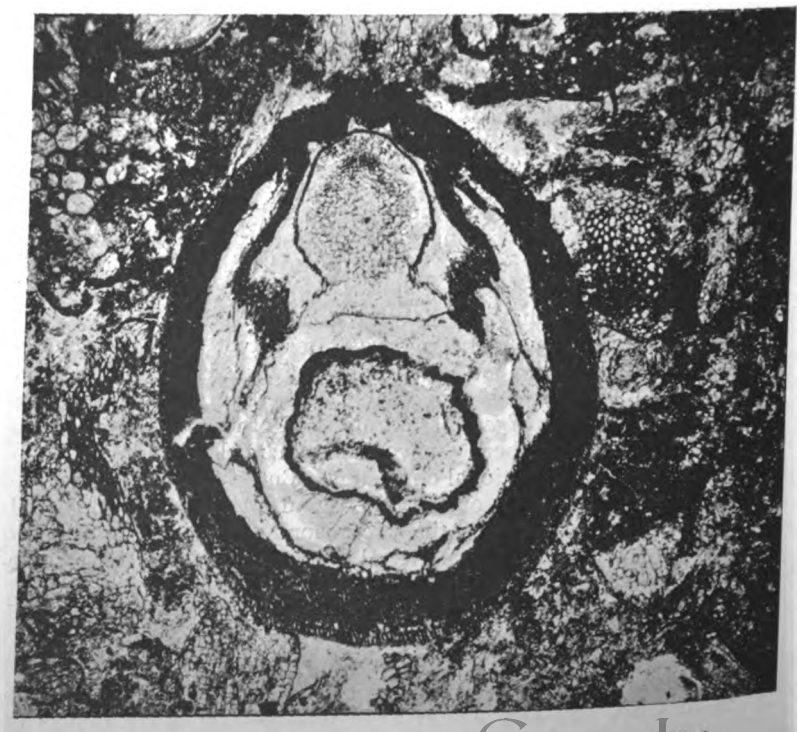

Fig. 3.—Longitudinal section of a "Lagenostoma" seed—magnified.

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respect. Many others of the Cycadofilices probably bore seeds, and it will be a matter of some interest to ascertain how early in the Fern-Cycad series the seed habit originated.

When, in connection with this discovery, it is remembered that Cycads possess a marked relic of filicinean ancestry in the motile spermatozoids through the agency of which fertilisation is effected, it will be realised how perfect is the bridge connecting the Vascular Cryptogams and Gymnosperms. That the latter originated from the Ferns seems now practically certain, but it must be borne in mind that this conclusion was anticipated from the results obtained from the purely anatomical investigation of the vegetative organs of the Cycadofilices. And this is of importance, for it is just such characters which are being widely employed in various parts of the Vegetable Kingdom in tracing out questions of phylogeny or ancestral history.

It has been suggested that others of the Cycadofilices may have resembled *Lyginodendron* in bearing seeds. Scores of unallotted seeds have been obtained from the carboniferous and other primary rocks. In this country the number of seeds preserved as petrifactions is not very large, but they are to some extent supplemented by others known in the form of casts or impressions. The French strata of Permo-carboniferous age, however, are rich in seeds. Now we have evidence that real Gymnosperms existed even as far back as Devonian times, a forest vegetation comparable to the coniferous forests of the present day. A certain number of the seeds referred to has been traced to these Gymnosperms—the Cordaiteæ is the name given to the group. But it has never seemed probable that the Cordaiteæ would account for more than a fraction of the available seeds, many of which, like *Lagenostoma*, were borne probably by fern-like plants. But the process of sorting out and allocating these seeds to their appropriate plants will not be an easy task. *Lagenostoma* is, perhaps, exceptional in sometimes carrying with it the means of identification. Be this as it may, additional results as they accrue should show us, it may be hoped, just where the seed-bearing habit originated. And if any very primitive seed type should lend itself to allocation, thus taking its place in the series, that would be the most interesting result of all.

The Forerunner of Moses.

The Laws of Hammurabi.

IN the progress of knowledge in recent years nothing has been more curious and interesting than the illumination of the dark places of history through the study of cuneiform inscription. Indeed, the preservation of Babylonian history and literature, which archæological researches in forgotten Eastern cities have revealed, is only less wonderful than the preservation and influence of the Hebrew writings themselves, an influence co-extensive with civilisation. The Babylonian inscriptions are, of course, chiefly interesting on account of the light they throw upon Jewish history. Until recently the Old Testament was a thing apart in literary history; it relates events which took place in times to which the age of classical antiquity barely reaches. From about 550 B.C. the Bible was the only source of the history of the nearer East; cuneiform discovery has illumined the whole of Old Testament history, for from beginning to end Hebrew antiquity is intimately connected with Babylonia and Assyria.

The whole subject of cuneiform discovery has recently been put within the reach of English readers in popular form by Messrs. Williams and Norgate's translation of "Babel and Bible," the two famous lectures which the great German Assyriologist, Professor Delitzsch, delivered before the Emperor.

As early as about 2250 B.C. there existed in the Babylonian Lowland a highly-developed constitution and a state of culture that might compare with our Middle Ages. As late as, and later than, 1400 B.C. the Babylonian tongue was the official language of diplomatic intercourses, Babylonian culture and literature the all-ruling influence from the Euphrates to the Nile. Thus the Children of Israel came into a land completely pervaded by Babylonian culture, by which they were profoundly influenced. Not the least remarkable feature of Babylonian civilisation was their Code of Laws, drawn up by Hammurabi, the contemporary of Abraham and the Amraphel of the Bible. Hammurabi lived about 2300 B.C., so that the Mosaic Code is of considerably more recent date.

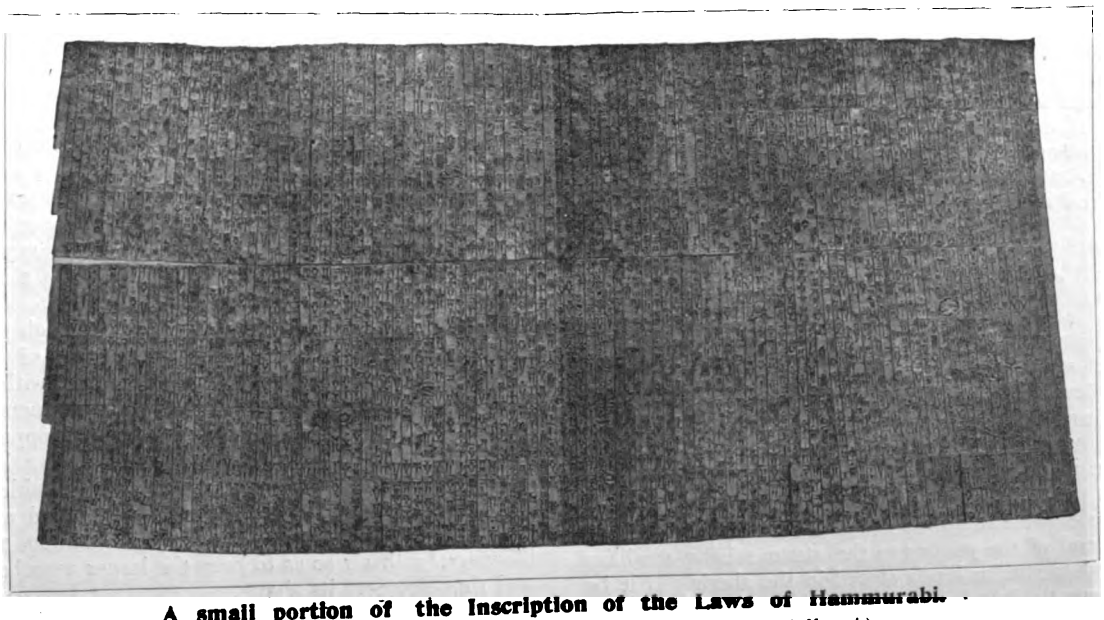
Hammurabi drove out the Elamites, the hereditary foes of Babylonia, and united the North and South into one State, with Babylon as its political and religious centre. He then proceeded to enforce a uniform code of laws. His code defined the civil law in all its branches. The relations of master to slave and labourer, of merchant to agent, of landed proprietor to tenant farmer, are strictly regulated. There is a law to the effect that the agent who pays over money to his principal for goods sold must receive a receipt from the latter; abatement of rent is provided for in the event of damage by storm or flood; fishing rights for each village situated on a canal are accurately defined. Every able man is bound to serve as a soldier, although precaution is taken against a too excessive use of conscription by means of numerous decrees recognising the privileges of the old priestly families, or exempting

Hammurabi receiving the Laws from the Sun-God.

From "Babel and Bible" (Williams & Norgate).

shepherds from military service in the interests of cattle-breeding. Babylon is the seat of the Supreme Court, to which all difficult and contested law-suits are to be referred for decision. On the summit of the stone which bears the law is a bas-relief of Hammurabi receiving them from the Sun-God, the Supreme Judge of Heaven and Earth. Below are engraved the 282 paragraphs of the laws. This diorite block was discovered at the beginning of 1902 by the French Archæologist, de Morgan, and the Dominican Monk, Sheil, among the ruins of the Acropolis of Susa, where it had evidently been carried off from Babylon by the Elamites as war-booty. The laws have since been translated by President Hugo Winckler, of the University of Berlin.

The series begins with 128 laws that refer chiefly to property rights and business affairs. Of these here are some that are characteristic:



A small portion of the Inscription of the Laws of Hammurabi.

From "Babel and Bible," by Professor Friederich Delitzsch (Williams & Norgate).

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2. If anybody raises a suspicion against another and he against whom this suspicion has been raised goes down to the river and jumps into the water, and if then the river seizes him, then he who has charged him can take possession of his property. But if the river declares him to be guiltless and he remains unhurt, then he who has raised the false accusation shall be killed and he who has jumped into the river shall have the property of his accuser.
5. If a Judge has charge of a trial and passes a judgment and this judgment has been given effect, and if afterward it turns out that this judgment has been false and the Judge is then convicted of having given a false decision, then he shall return the fine he has inflicted twelvefold, and he shall be deprived of his office as Judge and shall never return to this office.
6. If anybody robs either the temple or the royal palace he shall be killed; and he who has received such stolen goods shall also be killed.
15. If anybody takes out of the city gate the male or the female slave of the palace or of a freedman he shall be killed.
21. If anybody breaks a hole into a house he shall be killed in front of this hole and shall be burned there.
48. If anybody has a debt to pay, and a storm destroys his land, or the harvest is wrecked, or there has been a lack of water, then he is not obliged to pay the owner any grain for this year nor shall he be compelled to pay interest.
108. If the [woman] keeper of an inn harbours in her place those who conspire and does not report them, then she shall be killed.
117. If anybody cannot pay his debts then he can give his wife or son or daughter into the house of the creditor to serve for three years, but in the fourth year they shall be free.
132. If the finger [suspicion] has been raised against the wife of a man, but she has not been proved guilty, then she shall for the sake of her husband jump into the water.
141. If anybody's wife, who lives in his house, proposes to leave it and has been guilty of squandering and making debts, and neglects her husband, then she shall be brought before the courts; and if the husband then pronounces her divorce, she shall go her way, but receive nothing. If the husband does not divorce her, then she shall be a servant in the house of her husband.
168. If anybody desires to discard his son, and he says before the Judge, "I desire to discard my son," then the Judge shall examine his reasons, and if the son has not been guilty of great wrongs which justify his rejection as son, then his father shall not reject him.
169. If on the other hand, he has been guilty, then the first time it shall be forgiven him; but if he is for a second time guilty, then the rejection shall follow.
195. If a son strikes his own father, his hands shall be hewn off.
196. If anybody strikes out the eye of another, his own eye shall be forfeited.
197. If anybody breaks the bone of another, his bone, too, shall be broken.
200. If anybody destroys the teeth of his equal, his teeth, too, shall be broken.
215. If a surgeon causes a severe wound with his knife, he shall be fined ten shekels of gold.
218. If a surgeon through his operation causes death for the patient, he shall be killed.
229. If a builder erects a house for another, and it is not well made and it falls down and kills the owner, then the builder shall be killed.
245. If a person hires an ox and by his bad treatment kills the animal, he shall give the owner another ox in the place of the first.
282. If a slave say to his master: "Thou art not my master!" then his lord shall cut off his ear.

In the conclusion of this code Hammurabi repeatedly calls himself "King of Righteousness," as did his contemporary Melchisedek of Jerusalem, and enjoins upon all of his successors upon the throne to observe this code and its laws.

Storing Coal Under Water.

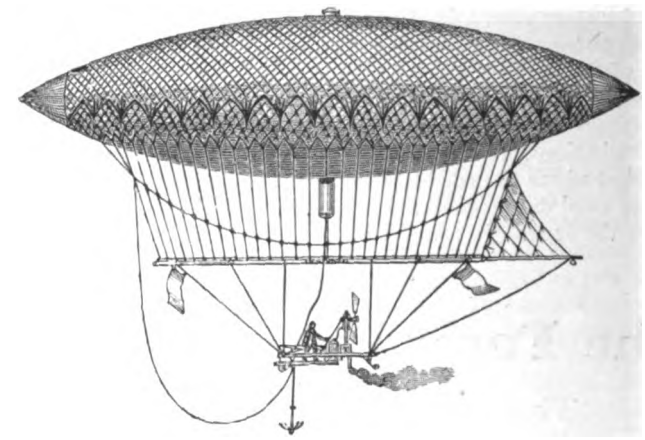
AN interesting experiment is now being tried by the Admiralty at Portsmouth Dockyard regarding the storage of coal. As is well known, coal rapidly deteriorates when exposed to the air. It also occupies much valuable space on wharves and other places where it is stored. A thousand tons, if piled 20 ft. high, would occupy an area of 20 ft. by 100 ft. The idea, therefore, of storing it at the bottom of the sea seems to be a good one. Large wooden cases are filled with coal and sunk in a considerable depth of water in the harbour. Tests are to be made at the end of the year as to the steam-raising qualities of the coal as compared to similar kinds stored in the sheds. If it be found that it has not greatly deteriorated, the system should prove of great value at some of our coaling stations.

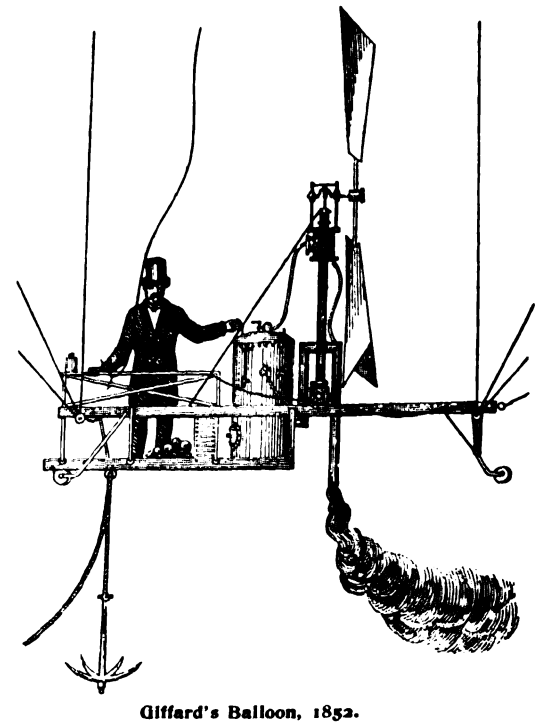
The Propulsion of Balloons

BY MAJOR B. BADEN-POWELL.

THE coming summer seems to promise some further developments in the navigation of the air by means of propelled balloons. Already M. Santos Dumont has made trials with his small experimental airship, No. 9. MM. Lebaudy have also finished their large machine, and made successful trips in it. In San Francisco the "Stanley" airship is being constructed. In London Messrs. Spencer are at work on a new and improved navigable balloon. At Aldershot the military authorities have been devoting their energies to this matter, and Col. Renard, of the French Military Balloon establishment, is also supposed to be bringing out a new vessel. Besides all these machines, which we may expect to see in the air before many weeks are over, there are others, including that of Dr. Barton, and a huge machine to be constructed by M. Godard for Senor Jose de Patrocini, which may perhaps be built before the end of the year.

It seems, then, a favourable opportunity to look back and shortly review what has been done in the past, as the subject is one which has not been very carefully followed by the general public. Many people have even supposed that the idea of an elongated, screw-propelled balloon originated with M. Santos Dumont, he having done so much in recent years to bring the matter forward.





Giffard's Balloon, 1852.

The first mechanically-propelled balloon to ascend was that of M. Giffard, which made its début as long ago as 1852 in Paris. This machine was remarkable in many ways, and its general principle has been followed out in most of the recent inventions. It was spindle-shaped, 150 ft. long, by 40 ft. in greatest diameter. It was propelled by a steam engine of 3-horse power working a screw propeller 11 ft. diameter. The first ascent took place in September of the above year, but the wind was too strong to stem, although it was calculated that the balloon travelled at an independent rate of five to seven miles an hour. Other ascents were made later on, but without any more success. Three years later the same inventor constructed another somewhat similar balloon, but the subject was again dropped until M. de Lome, in 1872, conducted some experiments with a large balloon for the French Government, from which several valuable data were obtained. Among other novelties this apparatus included a "ballonet" or small air balloon placed inside the large gas balloon, and capable of being blown out with air so as to keep the larger vessel completely distended, and thus preserve its shape.

A German aëronaut, named Haenlein, shortly afterwards built a balloon 150 ft. long with a gas engine. But it

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failed to ascend. In 1882-3, Mr. Gower and M. Debayeux tried a large steam balloon to be propelled in rather a novel manner. A flat-bladed fan was rotated in front of the balloon so as to rarefy the air and thus draw the aërostat after it by suction. But it was apparently not found to be sufficiently satisfactory to warrant making a regular ascent. M. Tissandier, in 1884, constructed a balloon to be driven by an electric engine, but he also was unable to provide sufficient power to go against the wind.

Soon after this came the remarkable experiments of Captains Renard and Krebs, who constructed, at the French Government balloon establishment at Chalais-Meudon, a large navigable balloon, which proved most successful. This machine, called "La France," was the first to be propelled through the air for some miles and to return to its point of departure. It was fish-shaped, that is to say, had its greatest diameter forward of the centre, and was 165 ft. long. The power used to operate the screw (which was placed in front of the long car instead of behind) was electricity. With the propeller revolving 48 revolutions per minute, the vessel was driven over 12 miles an hour through the air. The screw was two-bladed, seven metres across.

The first ascent was on the 9th of August, 1884. It lasted 25 minutes, and the balloon, having taken a tour around the neighbourhood, returned safely to its point of departure. On the 12th of September following, a second journey was attempted, but, owing to some mishap, was not a success. The third attempt on the 8th of November resulted in the vessel making a successful trip to Billancourt, about four kilometres distant, and returning. Later the same day another ascent was made, and after 35 minutes' manœuvring in the air a safe return was accomplished. In the next ascent, on the 25th of August, 1885, the wind proved too strong, and a descent had to be made at Villacoullay. Two more trials were made on the 22nd and 23rd of September, both of which were most successful; on the latter occasion the balloon went to Paris and back to Meudon at the rate of 14½ miles per hour.

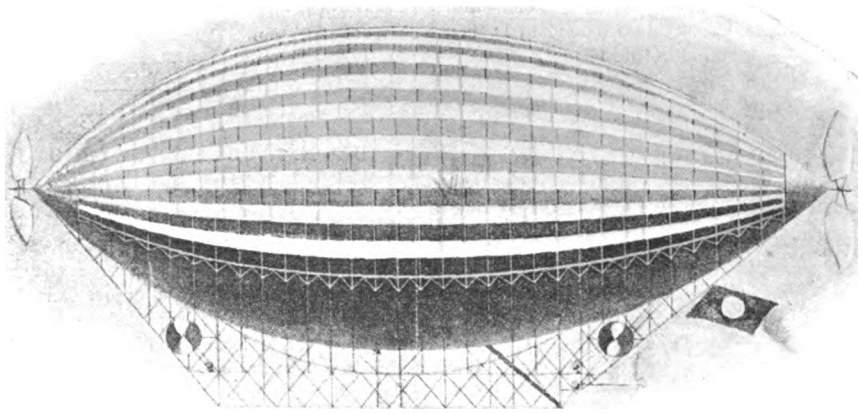
During the next 10 or 12 years a number of navigable balloons were constructed, but, unfortunately, ill-success dominated all of them. In 1886, M. Yon brought out an airship, and the following year Dr. Wolfert tried one. But these were both failures. The latter tried again with a new machine, worked by a gas engine, in 1896, without much success.

The following year a balloon was constructed in Germany, the invention of a Herr Schwarz, entirely composed of aluminium. It contained 130,000 cubic ft. of gas, and was propelled by a Daimler motor of 16-horse power, driving two aluminium propellers as well as a vertically-acting screw to give the required rise and fall. On November 3rd an ascent was made, but the propeller belts slipped off their pulleys, and the vessel, becoming unmanageable, was wrecked by the wind on its descent. In June 1897, Dr. Wolfert again made an ascent in a balloon propelled by an 8-horse power benzine motor. But after a short time the gas caught fire, probably from the exhaust flame of the engine, and the apparatus was dashed to earth and the two aëronauts killed.

The first motor-propelled balloon to ascend in England was built by M. Gaudron, and made an ascent from the Alexandra Palace in May, 1898. But, being 28 ft. in diameter, and the petrol engine only 2-horse power, it was quite unable to go against the light wind then blowing.

In September, 1898, M. Santos Dumont made the first of his experiments, which have been continued with such success. On this occasion the machine he ascended in was cylindrical with conical ends, being 83 ft. long and 12 ft. diameter. It was intended that it should be kept rigid by a "ballonet" of 880 cubic feet, but the pump with which the latter was to be kept inflated having failed to act, the balloon doubled up and descended to the ground.

The next event to chronicle is the construction, in 1899, of the extraordinary airship of Count Zeppelin. This differed in many material points from its predecessors. It was of enormous size. The shape was a long cylinder with pointed ends, being no less than 420 ft. long and 37 ft. diameter. The framework was built up of aluminium, over which a canvas cover was stretched, and 17 complete balloons were placed inside. The engines consisted of two 15-horse power Daimler motors, and these were geared to four small four-bladed screws each 3 ft. 6 ins. diameter, and placed at the sides of the vessel.

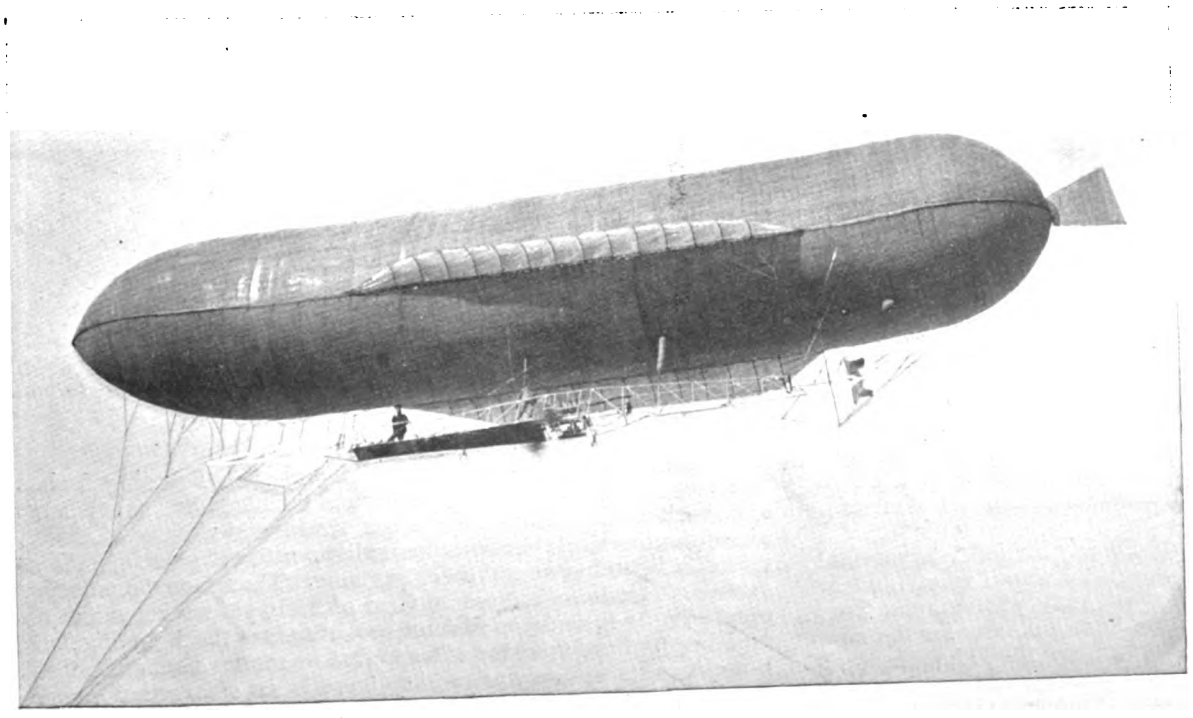


Severo, 1902.

In October, 1900, the machine made several ascents over Lake Constance, carrying five men. But minor accidents continually prevented a proper trial being made. On one occasion, however, the balloon returned to its point of departure after being 20 minutes in the air. It was estimated to have travelled at the rate of 18 miles an hour through the air.

There were two other attempts about this time to propel balloons by manual power, one in the United States by Mr. Carl Myers, and the other at Zurich by Mr. Henry Suter. Neither appear, however, to have met with any great success.

It will, perhaps, be best to leave to another article the account of M. Santos Dumont's many trips in his several balloons, and it merely remains to make reference to three other airships which were tried during last year. Senhor Severo built a rather novel form of balloon in Paris. The two propelling screws were placed at the two ends of the balloon, and were driven by two Buchet petroleum engines of 16 and 24-horse power. Another screw in the car was to be used for rising and descending. A most distressing disaster attended the first ascent of this apparatus, which caught fire in mid-air and dashed its unfortunate inventor and his assistant to the ground.



De Bradsky, 1902.

The second navigable balloon, tried a few months later by M. de Bradsky, also had a fatal ending, the car breaking away from the balloon.

The third machine was that of Mr. Stanley Spencer in London, which, like its predecessors, failed to stem the breezes, but which, we are happy to say, bore its inventor to a safe descent, and we hope to have to chronicle more successful trials in the new balloon of this intrepid aëronaut.

In the next article I propose to describe the various machines which have been constructed during this year.

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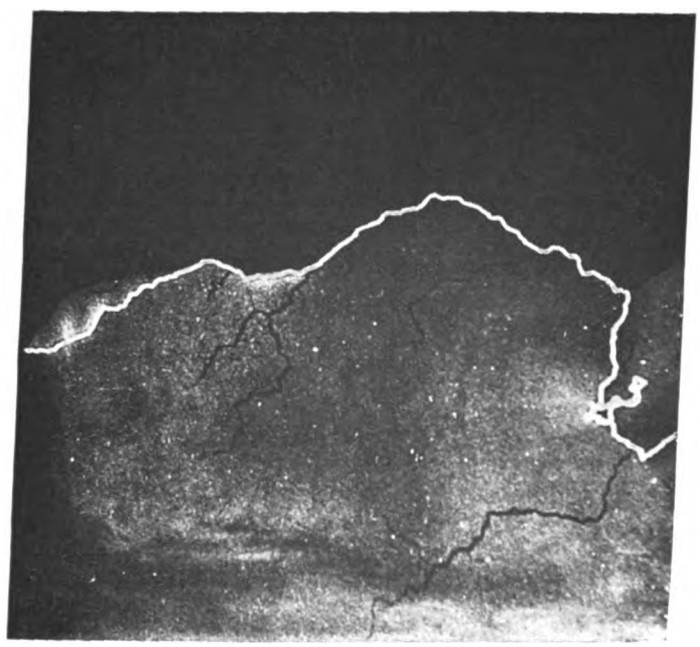
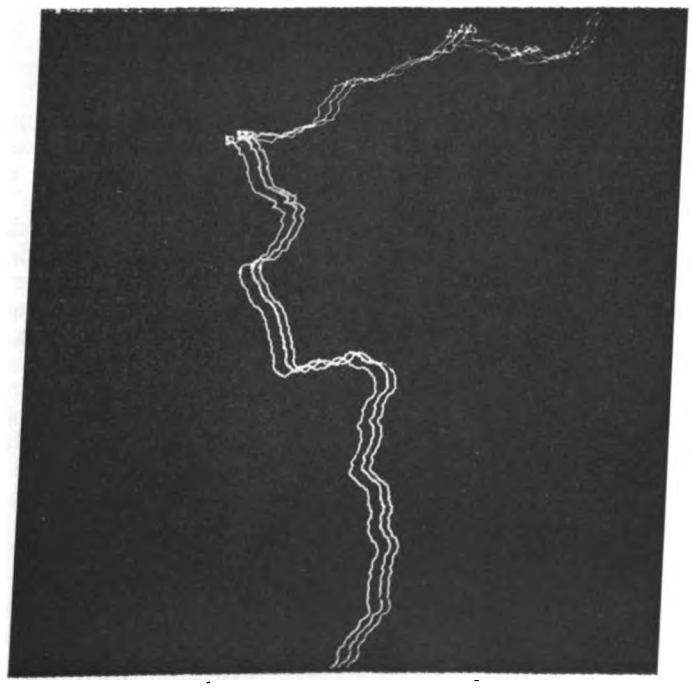
Lightning Flash Photography.

BY ERIC STUART BRUCE, M.A., F.R.MET.SOC.

THERE could be no better example of the value of the modern sensitive photographic plate as an eye of science than the revelations of photographs of lightning. Until the method of exposing plates during thunderstorms so that they may be traps for the records of lightning flashes was devised, the general conception of the forms of lightning flashes was exceedingly vague. Even in text books on physics, lightning flashes were divided into two classes only, "sheet lightning" and "forked lightning." Most painters of lightning flashes were content with depicting lightning in the form of an angular zigzag. The observant Turner, however, in his "Stonehenge" and "Bass Rock," depicted flashes which may favourably compare to some of the forms recorded on the photographic plates. Ruskin, too, knew something of the form of the flash, for in his "Modern Painters," when criticising Turner's 'Stonehenge," he describes the lightning in that picture as "The white lightning," not as it is drawn by less observant and less capable painters in zigzag fortifications, but in its own dreadful irregularities of streaming fire.



Sinuous and Dark Flash.



Ribbon.

In 1887 the Royal Meteorological Society invited international aid in the collection of photographs of lightning flashes, and in answer to this invitation received some sixty photographs from various parts of the world. These have formed a basis for the new classification of lightning flashes proposed by the Thunderstorm Committee of the Royal Meteorological Society, and published in the Quarterly Journal of the Society in July, 1888. In this classification six typical forms of lightning flashes are described

1. Streaming lighting, a form of seemingly rare occurrence, described in the report of the Thunderstorm Committee of the Royal Meteorological Society as "a plain, broad, rather smooth streak of light." 2. Sinuous lightning, which is the commonest type. 3. Ramified lightning. 4. Meandering lightning. 5. Beaded lightning. 6. Ribbon lightning. This latter appears due to photographic causes, and, if so, is really not typical of lightning flashes. The ribbon appearance seems in some cases to be due to the flash being out of focus, in others to the movement of the camera, when the ribbon appears to be formed of re-duplications of the flash. The opinion, however, has been expressed that such a phenomenon appears in ordinary electric discharges. It has been shown that a lightning discharge is of an oscillatory nature, and it is probable that the return path would not be exactly the same as the discharge path. This might account for some of the multiple effects.

Ramified and Sinuous.

One of the most interesting features of Photographs of Lightning Flashes is the "Black Return," in which there is a bright flash with a parallel black line close to it. With regard to this subject, Lord Armstrong has made a number of experiments with electric sparks, and has traced the recurrence of the Black returns, or what may be called Black Flashes, to reversal in the plate, owing to the return of the current along the path of discharge, such path remaining the path of least resistance.

It has already been mentioned that most painters have depicted lightning in angular zigzags. Such a representation has not been confirmed by the photographic plate as true to Nature. But while it is improbable that lightning is often seen in long sharp angles, still it is not absolutely impossible that exceptional circumstances may arise when such an appearance can be seen. In 1890 the author of this article read a paper before the Royal Meteorological Society, in

Ramified and Sinuous.

which was suggested the possibility of projection lightning flashes. When we view the effects of a distant thunderstorm over a large area, such as the surface of the sea, sometimes a bank of clouds, sometimes the whole horizon appears lit up with a sheet of light. This species of lightning we call sheet lightning. Though on the reflecting surface of clouds we can see no form of flash, yet we know that the sheet of light is made up of countless images of the lightning flash, superimposed one upon the other so that we cannot distinguish them. But circumstances may arise when there is an obstruction between the lightning flash and the reflecting clouds in the shape of a cloud with one or more small openings in it. When this happens, if the opening in the cloud is sufficiently small, the cloud sufficiently

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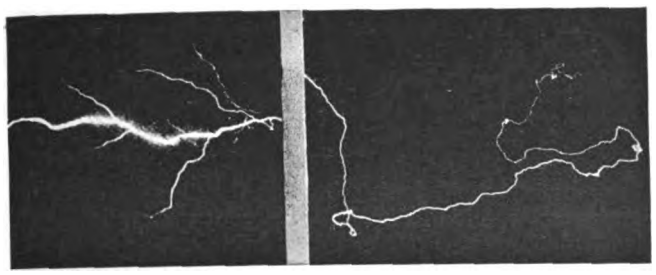
thin, and the lightning flash in an adequate position, on the clouds, which otherwise would have been illuminated by sheet lighting, there will appear the optical projection of a lightning flash. If the surface of clouds upon which the lightning flash falls is quite even we shall have a perfect reproduction of the lightning flash though it will be somewhat dulled in brilliancy. If, however, as might often be the case, the surface of clouds is of the cumulus rugged type, the projection of the flash will take the shape of the irregular surface, and there will be presented a flash very different from the original which

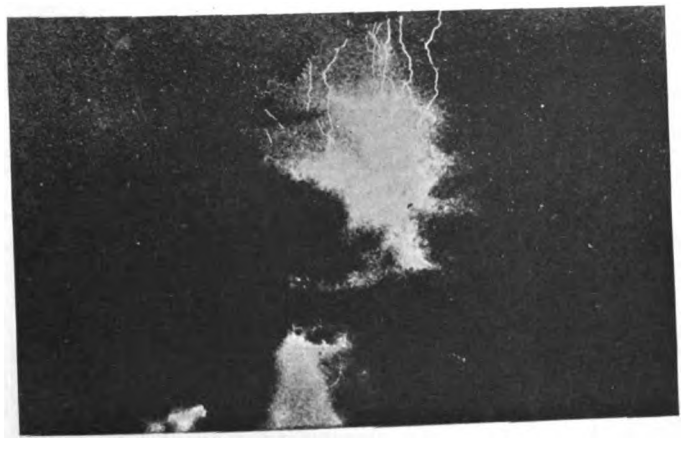


Ramified. **Meandering and Beaded.**

might in reality be a streaming flash devoid of bends or angles and yet appear not so very unlike the angular type which has often been presented by artists. The following observation was quoted by the author in a paper read before the Royal Photographic Society, December 24, 1897: "When travelling in Switzerland, some few years ago, the train was passing through a valley whilst there was a severe thunderstorm in progress. The valley was filled with wreaths of mist, forming an uneven surface; suddenly there appeared in the mist a very zigzagged flash of lightning, seemingly quite close to

Streaming.

the window of the carriage in which I was travelling. It was not of the intense brilliance that would have been expected of it if it had been the electric discharge itself at such very close quarters, but was dulled in brilliancy, so that I could see the form without my eyes being in the least dazzled, and I felt very inclined to think this was a projection flash." But when considering the effects of lightning, what may be called veiled lightning should also be taken into account, and it is quite possible that the flash seen in Switzerland described above might come under this head. Lighting flashes



Sinuous.

are often veiled from the eye by thin clouds, and most varied luminous forms and effects are seen through the medium of such translucent clouds. Therefore, in spite of the revelations of photographs of lightning flashes, some latitude must still be given to artists who depict thunderstorm phenomena before their work is condemned as unnatural.

It must be mentioned that the typical examples of lightning flashes with which this article is illustrated have been reproduced with the kind permission of the Royal Meteorological Society.

The Study of Solar Motion.

THE D. O. Mills expedition of the University of California, sent by the Lick Observatory to spend two years in studying the motion of stars in the line of sight, has now arrived at Santiago. The object of the investigations which are to be carried on is to throw light on the great problem of the movement through space of our solar system. The expedition is headed by W. H. Wright, assistant astronomer of Lick Observatory.

About a century ago Tobias Mayer found that in the region of Arcturus and Vega there is a slight separation of the stars. In the region of Sirius and Aldebaran, on the contrary, the stars approach. Mayer concluded that this apparent change was due to perspective, and that the sun, and the planets which revolved around it, were moving toward the region of Arcturus and Vega. Mayer's theories have been confirmed. The direction of motion was more easily determined than the velocity. After many attempts had been made, Prof. W. W. Campbell, of the Lick Observatory, adopted a vrey ingenious method which gave valuable results.

When a luminous body which is moving away from the observer is examined in a spectroscope, the lines which appear in its spectrum will be shifted out of their true position in one direction, but are moved to the other side if the body is approaching the observer. Similar effects are observed if the body be stationary and the observer's position changes. The degrees of displacement of the lines enable one to determine the rate of motion in the line of sight.

An especially powerful spectroscope was constructed, with the aid of which the velocity of the solar system was determined. Prof. Campbell, after having studied the motions of some 283 stars, concluded that the sun was moving at the rate of 12 miles a second. A continuation of the studies has not led him to alter the conclusion which he has reached.

At Mount Hamilton, where Prof. Campbell studied solar motion, the astronomical field is comparatively limited. Many portions of the southern heavens can never be seen at all. In order, therefore, to determine with absolute accuracy the velocity of the motion of the solar system, it was necessary to study the motion of the stars in the southern hemisphere. It is for this purpose that the D. O. Mills expedition has been dispatched southward. Of the instruments which have been taken along, the most important is a reflecting telescope made by Brashear. Its aperture is over 36 inches. Its focus is 17½ feet from the concave mirror. About two years will be spent in studying the stars in the southern hemisphere.

An Apothecary's Oath of the Fourteenth Century.

THE Journal Medical de Bruxelles refers to a case before the criminal tribunal of the Cour de Cassation, in which the point at issue was whether it was allowable for physicians and pharmacists, though practising different yet allied professions, to enter into partnership. Maitre Momard, representing the affirmative, showed that the profession of pharmacist had been from remote times a dependent of that of medicine, and in support of this view cited a curious oath of the fourteenth century which used to be taken by the "apothicaires" of those days. The oath is as follows: "I swear not to malign any of my former masters, physicians, pharmacists, or others, whoever they may be; to uphold, as far as in me lies, the honour, glory, ornament and majesty of medicine; not to disclose to idiots and ingrates their secrets and mysteries; to do nothing rashly, without the counsel of physicians or in the hope of gain; to disown and to avoid like the plague the disreputable and entirely pernicious methods of practice now followed by charlatans, empirics, and dabblers in alchemy, to the great disgrace of the magistrates who tolerate them. May the Lord prosper me as I observe these conditions."

Bee Culture as an Industry.

FRUIT culture and bee culture have both been recommended to the distressed British agriculturist; and, perhaps, the advice has sometimes been supererogatory. It is permissible, however, to draw attention to the way in which the honey industry has advanced in France during the last few years. In ten years the output of honey has increased from 7,000,000 kilogrammes to 8,500,000 kilogrammes. The increase is due less to an increase in the number of hives than to the greater yield of each hive, which has now risen to about 500 grammes, or 11 lbs., a hive. What is more gratifying (to the French producer) is that owing to the scientific methods of bee-farming the yield each year has become more constant and less affected by vicissitudes.

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The Prevention of Typhoid.

IN a previous number of the ILLUSTRATED SCIENTIFIC NEWS we have referred to the experiments which Dr. Allan MacFadyen has been making at the Jenner Institute of Preventive Medicine on the intracellular poisons of bacteria. The apparatus with which these experiments in their latest development are being made was shown at the recent *soirée* of the Royal Society; and consisted of devices by which the colonies of pathogenic bacteria could be triturated. In the first method the cells are disintegrated by the violent impact of sand particles. In the second method the use of extraneous disintegrating material is dispensed with, the cells or organisms being disintegrated when in a frozen condition. The necessary brittleness is secured by freezing, and the freezing is accomplished by means of liquid air. It must be premised that these experiments are at present in the laboratory stage. The hopes for the future which may be entertained as the result of them will be best understood by the following abstract of Dr. MacFadyen's paper read before the Royal Society.

The typhoid cell-juices obtained by this method on inoculation into animals proved toxic or fatal. It was, therefore, concluded that the typhoid bacillus contained within itself an intracellular toxin.

It remained to test the typhoid cell-juices for immunising and other properties. The preliminary experiments in this direction, which form the subject of the present note, were made upon the monkey. The monkey was selected as an animal most likely to furnish data of possible application to man. For this purpose the typhoid cell-juice was administered subcutaneously to the monkey. The injections did not produce any general symptoms beyond a transient rise in temperature, whilst the material was quickly absorbed after each injection without any traceable local effect. In this manner doses of 0·5 to 1 c.c. of the material were injected at intervals. An immediate result was the agglutination of the typhoid bacillus by the serum of the blood of the treated monkeys, whereas no such effect was produced by the serum of monkeys which had not been treated. This furnished useful evidence that the animals were under the influence of cell-juices derived from the typhoid organism. The injections were repeated at intervals of three to four days, and after a lapse of four to six weeks the animals were bled. The serum obtained was then tested for immunising properties. The test objects were (1) a virulent culture of the typhoid bacillus, and (2) the intracellular toxic juice of the same organism. A varying amount of the virulent bacilli and of their toxic cell-juice was mixed with a varying quantity of the serum. The respective mixtures were then injected into the peritoneal cavity of the guinea-pig.

The broth cultures of the typhoid organism used in the experiments were *per se* lethal in doses of 0·1 c.c. in five to ten hours. The typhoid cell-juices were fatal in doses of 0·2 and 0·1 c.c. in three to five hours, and in doses of 0·05 c.c. in about twelve hours. The serum was thus tested for (1) specific antibacterial and (2) specific antitoxic properties.

The experiments showed that the serum of the monkey, after injections of the typhoid cell-juices, possessed antibacterial and antitoxic properties, inasmuch as the serum protected the experimental animals against the bacilli, and also against an intracellular toxin obtained from them.

A simultaneous injection of (1) serum with the bacilli, and (2) serum with the toxic cell-juice produced no lethal or toxic effects. The control animals, on the other hand, invariably succumbed.

It was further investigated whether the serum possessed preventive and curative properties. The serum from treated monkeys was injected into guinea pigs, one injection being made in each instance, and the same animals received at an interval of 12 to 24 hours lethal doses of the typhoid bacillus and of its toxic intracellular juice respectively. The treated animals survived the test, while the control animals succumbed. It was therefore concluded that the serum had protective properties.

A third series of guinea-pigs received lethal doses of the typhoid bacillus and of its toxic cell-juice respectively. The serum was then injected at various intervals into individual animals. It was found that the lives of the animals could be saved by one injection of the serum from a fatal infection or intoxication, even when half of the lethal period had elapsed in each instance. The serum, therefore, possessed curative properties.

In view of the above results, it appeared desirable to test the effect of the typhoid cell-juices upon animals larger than the monkey, in order that a greater amount of serum might be obtained conveniently and tested quantitatively as regards antibacterial and antitoxic properties. These experiments are at present in progress, and the results will be communicated in due course.

From the experiments made upon the monkey it would appear—

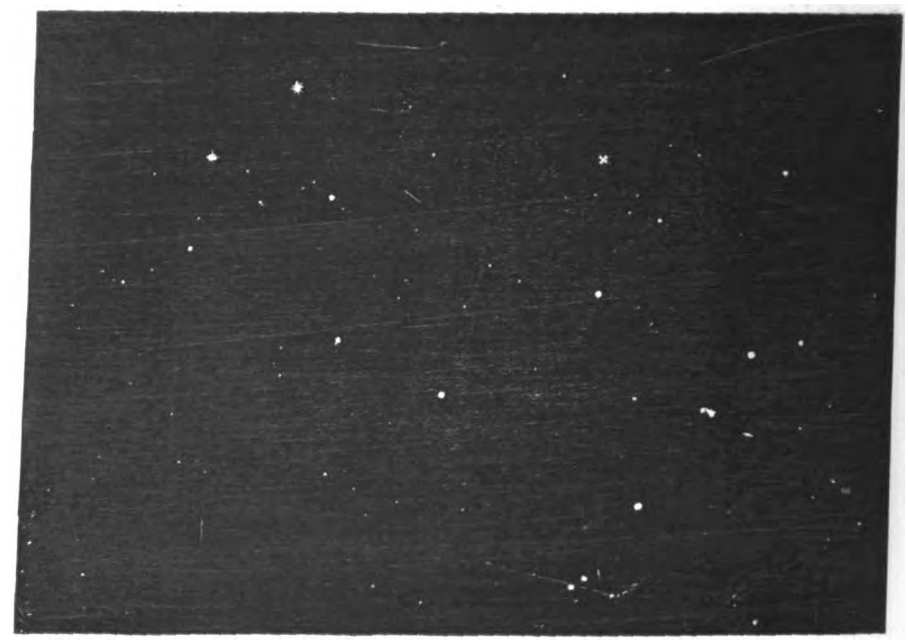
(1.) That by the injection of the intracellular juices of the typhoid organism into the monkey it is possible to obtain a serum with both antibacterial and antitoxic properties.

(2.) That such a serum possesses curative and preventive properties as regards the typhoid bacillus and an intracellular toxin present in the same organism.

It is believed that this research has afforded for the first time proof that, in the case of one species of pathogenic bacterium, the intracellular juices of the organism, when injected into a suitable animal, give rise to the production of a serum which is both bactericidal to the organism itself, and antitoxic as regards a toxin contained in its substance. How far such properties of the cell-juice are shared by other pathogenic microbes must be the subject of further inquiry.

The New Star in Gemini.

MANY astronomers have been searching their plates to see if they can discover any record of the Nova before it was reported on March 27th by Prof. Turner. Prof. Pickering has a negative of that region taken as late as March 1st, which shows stars of the 12th magnitude, but without any trace of it. On a photograph taken on March 6th there is, however, some image in this spot. Prof. Hale, of the Yerkes Observatory, has been making observations on this star with the 40-inch telescope. He reports it as having a strong red colour with a crimson glow around it. In Rome the colour is reported as yellow, but Dr. Halm, of Edinburgh, speaks of it as a "bluish purple." It appears to have been decreasing in magnitude since first reported. The magnitude has varied between seven and eight, so that it is invisible to the naked eye.



The Constellation of Gemini (X marks position of the Nova).

The position of the star is shown in the accompanying illustration, but its situation in the heavens is not very suitable for observation, being so low on the western horizon.

Weather Observation.

SOME time ago Professor Schüster rather rashly remarked to a section of the British Association that he believed meteorology would be advanced if all the meteorologists would cease taking observations for a couple of years and devote their intellectual energies to the task of interpreting the results and statistics which had been collected. Probably the professor, who is a member of the British Meteorological Council, meant no more than that a good deal of good might result from the correlation of observations—as, for instance, has been shown in Sir Norman Lockyer's comparisons between the synchronous barometric pressures of India and those of portions of the Western Hemisphere; or in Mr. Douglas Archibald's division of meteorological conditions into "weather types." But the *obiter dictum* seems to have stirred Professor Hann, who has translated the paper for the *Meteorolgische Zeitschrift*, to his depths, and he points out with all the zeal of an inductive race why it is necessary to collect data and to go on collecting them. One point, however, he makes, and that is in respect of the collection of data the service of which to knowledge is not immediately apparent. "When Schwabe began his sunspot record," says he, "it must have appeared to specialists a mere hobby devoid of all scientific object. Had it been otherwise, astronomers would undoubtedly have commenced such observations earlier. And what scientific value have these observations now attained to!"

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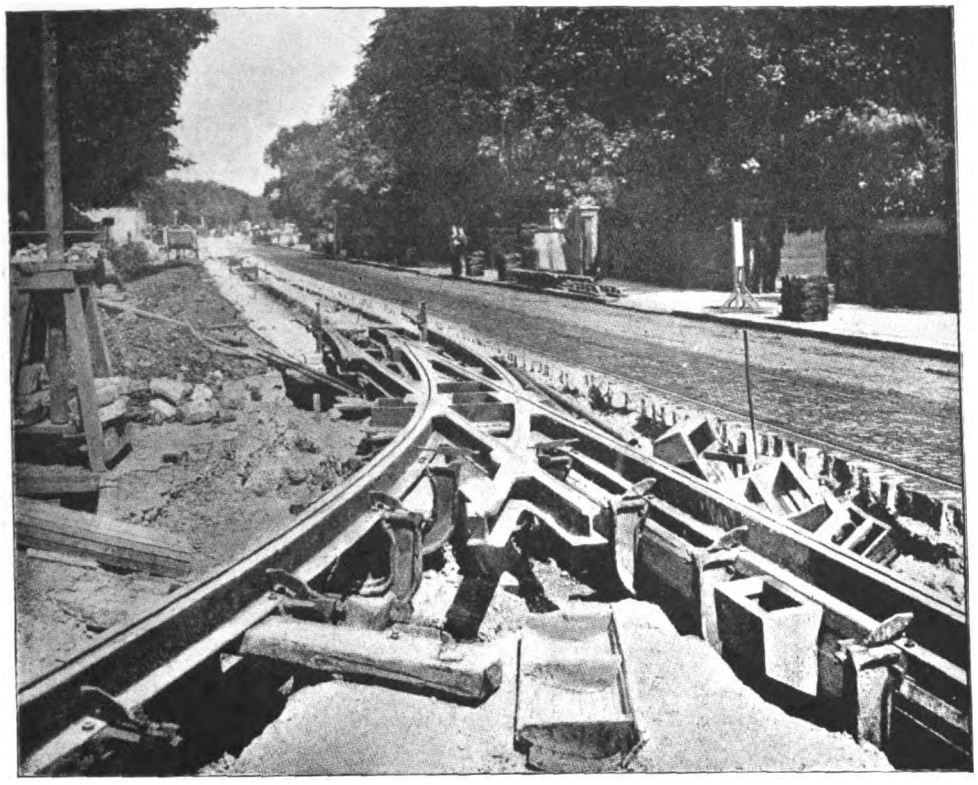
The Conduit Electrical Tramways.

THE system of electrical tramways in South London which the Prince of Wales inaugurated last month marks a departure not alone in the problem of inter-urban communication in London, but in electrical traction as applied to tramways in England. In the great majority of tram-lines abroad, as well as at home, the overhead wire system has recommended itself because of its comparative cheapness, the ease of its construction, and its trustworthiness in working when it has been carefully constructed. To these advantages may be added the other



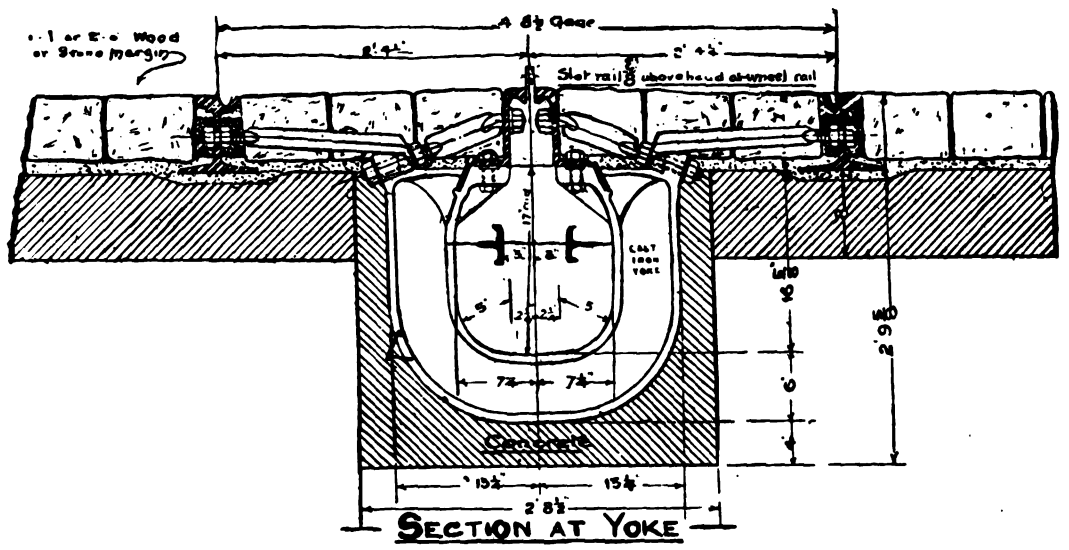
The County Council Conduit System—showing the laying of the conduit at a junction.

one of the easy repair of defects or accidents. Against these advantages have been set the undesirability of a complicated overhead system of wires at crossings, together with some minor defects such as the leakage of electric currents from the wires, and the obstruction, of a more or less objectionable kind, which overhead wires constitute in all thoroughfares, crowded or otherwise. The conduit system offers no obstruction to other traffic because its conductor of electricity is below the level of the street; properly constructed, it has no leakage of electricity to affect neighbouring wires or to corrode neighbouring pipes; it is next to impossible that any person should suffer accident by contact with its conductors. These foregoing considerations may all be regarded as theoretically accurate. Against those which are in favour of the conduit system we must add that one line constructed on the conduit system in England—the line at Blackpool—failed. It failed partly because the conduit was continually being blocked with sand, and partly because the ploughs which, attached to the trams, pick up the current from the underground rail were continually being broken. The overhead trolley system by which Blackpool has superseded its old conduit system has proved completely satisfactory. So far as obstruction caused by sand or dirt is concerned, the London County Council has made provision. So much a year is allowed for the cleansing of the conduit; and this conduit has been constructed in such a way as to make cleansing easy. Furthermore, the opening of the middle rail, through which the plough dips down to the rail, is specially narrow, and there is not very much danger that a large enough quantity of dirt will get in to stop the working suddenly. Similarly the flooding of the conduit by rain storms, which have been known to stop the working of the conduit tramway in New York, is unlikely. All things considered, the new conduit system has been built with great care, and though it has cost a good deal more a mile than was first estimated, we believe that it has a good chance of coming out of its test satisfactorily. It had some misfortunes on its opening days, but these have not been repeated; and finally, although it is only the second such system existing in England, that of Blackpool being the first, it has many contemporaries on the Continent and in the United States—at Buda Pesth, Paris, New York, and Chicago. The following is a detailed account of the system adopted.

The distinctive feature of the conduit system consists of two metal conductors placed along the middle of the track at some distance below the surface of the road in a specially-constructed tunnel. The current is picked up by a plough which is attached to the car, and which, passing through a slot in the road, makes contact with the conductors in the conduit or tunnel.

A double track of 4 feet 8½ inches gauge throughout is employed as shown in the drawing. The running rails are of steel and of the girder type, and weigh 102 lbs. per yard run. The slot rails are also made of steel, and each rail weighs 62½ lbs. per yard. The opening between the slot rails, forming the slot through which the plough works, is three-quarters of an inch wide. The conductors carrying the electric current are T-shaped rails of soft steel with specially high conductivity, carried within a concrete conduit as shown on the drawings; their weight is 22 lbs. per yard run. They are carried by insulated supports spaced 15 feet apart. Cast iron yokes, as shown on drawing, carry the slot rails, which are bolted through the bottom flange to the tops of the yokes, and it will be seen from drawing that they are further stiffened by a tie-bar bolting the slot rail web to a lug on the yoke-head. The yokes are spaced 3 feet 9 inches apart as measured along the centre line of the track. The normal depth from the top of the slot rail to the sill or floor of the conduit is 24 inches, and the base of the yoke (which bears upon a concrete foundation) is 6 inches lower, or 2 feet 6 inches below the surface of the road.

Access from the street to every insulator is given by cast iron boxes, consisting of frame and cover. The opening is 1 foot 4 inches by 1 foot 2 inches, and the cover is filled with the same material as the general paving between the rails. Means of draining the conduit are provided by deepening the insulator pits of every 50 yards, and laying pipes from the deepened pits to a sump in the margin, which in turn is connected with the sewer. The concrete used for the conduit is composed of five parts of sand to one part of Portland cement and is 8 inches thick under the track rails. The concrete for the paving base is composed of seven parts of sand to one part of Portland cement. The conductor bars are divided by section insulators into sections not exceeding half a mile in length. Each section of the conductor bars consists of a positive and negative length in each conduit. Normally the two conductor bars of the same polarity in each section are electrically connected at a switch pillar, and each section is supplied with current by a separate feeder from the sub-station. Switches for cutting out the various sections are provided in the feeder pillar. Automatic cut-outs and change-over switches are provided in the sub-stations for each section, which are so arranged



Drawing (c)—Section of the conduit at the yoke.

that in the event of a fault occurring and persisting on the positive of any section, the polarity of the two conductors in that section can be reversed, so as to throw the fault on to the negative, where it can remain until the stoppage of traffic at night allows it to be located and removed. The normal difference of potential of the conductors is 550 volts; and the insulated feeders for each section are drawn into stoneware ducts, which are laid either under the footpaths or under the road, according to circumstances.

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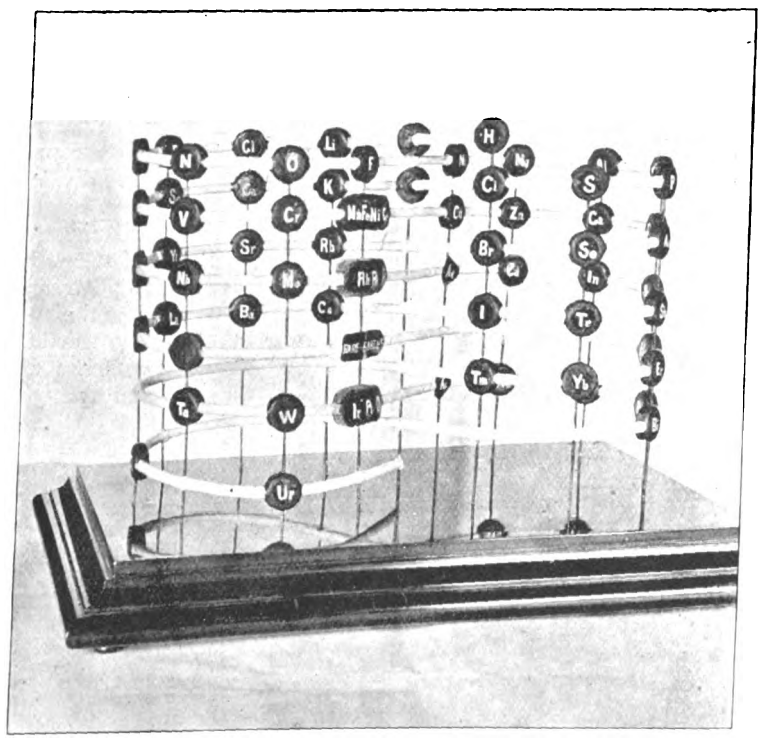
Radium.

BY E. S. GREW.

A VERY great deal has been written about radium; a great many theories have been formed about its properties; but after five years of examination and theory the greatest of English chemists has said that what we chiefly want in respect of radium is more facts. What is known of it; and why is its importance to science so great? The following appear to be the circumstances of its discovery. In 1898. five years ago, Professor Curie, Madame Curie, and M. G. Bemont announced that they had found a new element in pitch-blende residues, which was extremely radio-active. It was found in company with barium. By fractional precipitation, chlorides were obtained, containing the new element, which had 900 times the radiant activity of uranium, a metal which had been discovered by Sir William Crookes, and which is the principal element in pitch-blende. The amount of radium present was almost imperceptibly minute. But the radiations from this trace registered themselves on a photographic plate in half a minute, where other radio-active compounds would have taken hours. Its radiations after passing through aluminium rendered a film of barium-platinocyanide luminous enough to be visible in the dark.

In four and a half years' work the knowledge of radium's properties has greatly increased. It was found that the capacity for giving out radiant energy was joined to the ability, which uranium had been found by Sir William Crookes to possess, of imparting its radio-activity to other bodies. In other words, bodies subjected to the radio-activity of radium became themselves radio-active. "The persistence of radio-activity on glass vessels which have contained radium is remarkable. Filters, beakers, and dishes used in the laboratory for experiments with radium, after having been washed in the usual way, remain radio-active; a piece of blende screen held inside the beaker or other vessel immediately glowing with the presence of radium."* After some four years of labour, sufficiently pure samples of radium compounds have been obtained to enable its atomic weight to be ascertained. It has been found to have a probable atomic weight of 258. It is, therefore, the heaviest of all substances known. The atomic weight of gold is only 197; that of uranium, which is the metal next in atomic weight below radium, is 239.



Its place in the elements may, perhaps, be best appreciated by the accompanying diagram, which illustrates a convenient method of arranging the elements according to the Periodic Law. Several methods have been suggested for grouping the elements, of which the figure of eight in a descending spiral is one of the most interesting. Suppose† "that at the birth of the elements, as we now know them, the action of the *vis generatrix* might be diagrammatically represented by a journey to and fro in cycles along a figure of eight path, while simultaneously time is flowing on, and some circumstance by which the element-forming cause is conditioned (*e.g.*, temperature) is declining (variations which I have endeavoured to represent by the downward slope). The result of the first cycle may be represented in the diagram by supposing that the unknown formative cause has scattered along its journey the groupings now called hydrogen, lithium, glucinum, boron, carbon, nitrogen, oxygen, fluorine, sodium, magnesium, aluminium, silicon, phosphorus, sulphur, and chlorine. But the swing of the pendulum is not arrested at the end of the first round. It still proceeds on its journey, and had the conditions remained constant, the next elementary grouping would again be lithium, and the original cycle would eternally re-appear, producing again and again the same fourteen elements. But the conditions are not quite the same. . . . . and so instead of lithium being repeated by lithium, the groupings which form the beginnings of the second cycle are not lithium but its lineal descendant potassium." Thus, besides the lineal progress of the elements, we have, as it were, a descent from each element at right angles to the first path. The family likeness would show itself in a gradation of properties of each of the elements, some given quality increasing or decreasing as the atomic weight increased. Thus, from hydrogen we have the descending group, hydrogen, chlorine, bromine, iodine. From oxygen we have the descending group, Oxygen (atomic weight 16), Chromium (52), Molybedenum (96), Tungsten (184), Uranium (238). In order to find radium's place we should have to continue our spiral round another turn of the figure of eight. It is as it were in a cycle below that of any element hitherto known.

The most recently investigated property of radium is that of its ability to give out heat. MM. Curie and Laborde have found that radium in a more or less pure state gives out sufficient energy to melt half its weight of ice in an hour. The measurement of the energy might be otherwise stated as that pure radium gives out in two days as much energy as an equal weight of hydrogen and oxygen give out when they explode to form water. Other properties of the emanations from radium, which have become known, one might say popularly known, are the effect they have on the skin of human beings. The emanations of radium will pierce a glass tube, a cardboard box, and clothing—so that in one case, M. Becquerel, who had been carrying some radium nitrate thus enclosed in his waistcoat pocket, found his skin severely burnt. Chemists who carry radium about with them usually do so now with the radium enclosed in a pill box of thick lead.

But quite apart from these manifestations, the two characteristics of radium which endow it with its position of importance are the nature of the emanations from it; and its own almost isolated position at the far end of the atomic scale. What is the nature of the emanations? They continue, one might say, for immeasurable periods of time, and yet despite this vast display of energy leave the radium as it was. The same in weight, the same in energy. Professor William Ackroyd has suggested that the luminous effects produced on blende screens by the emanations of radium, as well as other instances of its radio-active power, might be explained on the hypothesis of "surface decrepitation of the radium"—that is to say, "by the crackling and flying asunder of their particles; or a breaking off and shooting away of minute pieces at the surface due to alteration of temperature." But this will not do. The emanations of radium are such that if it threw off a million of these immeasurably small particles which we now suppose to produce the luminescent and other effects, it would not lose a milligramme in weight in a thousand years. If the same effects were due to surface decrepitation, it might easily lose a milligramme in weight in a minute.

What, then, are the emanations? Very early in the investigations of the radio-active minerals Sir William Crookes was led to identify the emanations with the "Radiant Matter," which he assumed to exist after consideration of the properties of matter in highly rarefied tubes (Crookes' tubes)—matter in an ultra-gaseous state. "In studying this fourth state of matter* we seem at last to have within our grasp and obedient to our control the little indivisible particles which, with good warrant, are supposed to contain the physical basis of the universe. We have seen that in some of its properties radiant matter is as material as this table, whilst in other properties it almost assumes the character of radiant energy. We have actually touched the borderland where matter and force seem to merge into one another." The "radiant matter" of Sir William Crookes has found other names since then. Dr. Johnstone Stoney coined for it the name of "Electrons," and the doctrine of "electrons" may be said to be the latest development of the electrical theory of matter. The "electron" is the "electric atom," the "disembodied electric ghost" of Sir Oliver Lodge. It occupies the atom of matter, he has recently told us, as an army of soldiers occupy a country. It has no weight of its own; nothing but energy, perhaps we might say. A thousand, or a hundred thousand occupy an atom as a swarm of gnats in the globe of St. Paul's.

But the emanations from radium are not, Sir William Crookes believes, electrons alone. The emanations from radium are of three kinds. One set is the same as the cathode stream, now identified with free electrons—atoms of electricity projected into space apart from gross matter—identical with "matter in the fourth or ultra-gaseous state," Kelvin's "satellites," Thomson's "corpuscles" or "particles"; disembodied ionic charges, retaining individuality and identity.

Electrons are deviable in a magnetic field. They are shot from radium with a velocity of about two-thirds that of light, but are gradually obstructed by collisions with air atoms.

Another set of emanations from radium are not affected by an ordinarily powerful magnetic field, and are incapable of passing through very thin material obstructions. They have about one thousand times the energy of that radiated by the deflectable emana-

* Sir William Crookes' "The Emanations of Radium." Royal Society, March 19, 1903.

† Sir William Crookes. Royal Society.

* *Chemical News*, Vol. 40, p. 130.

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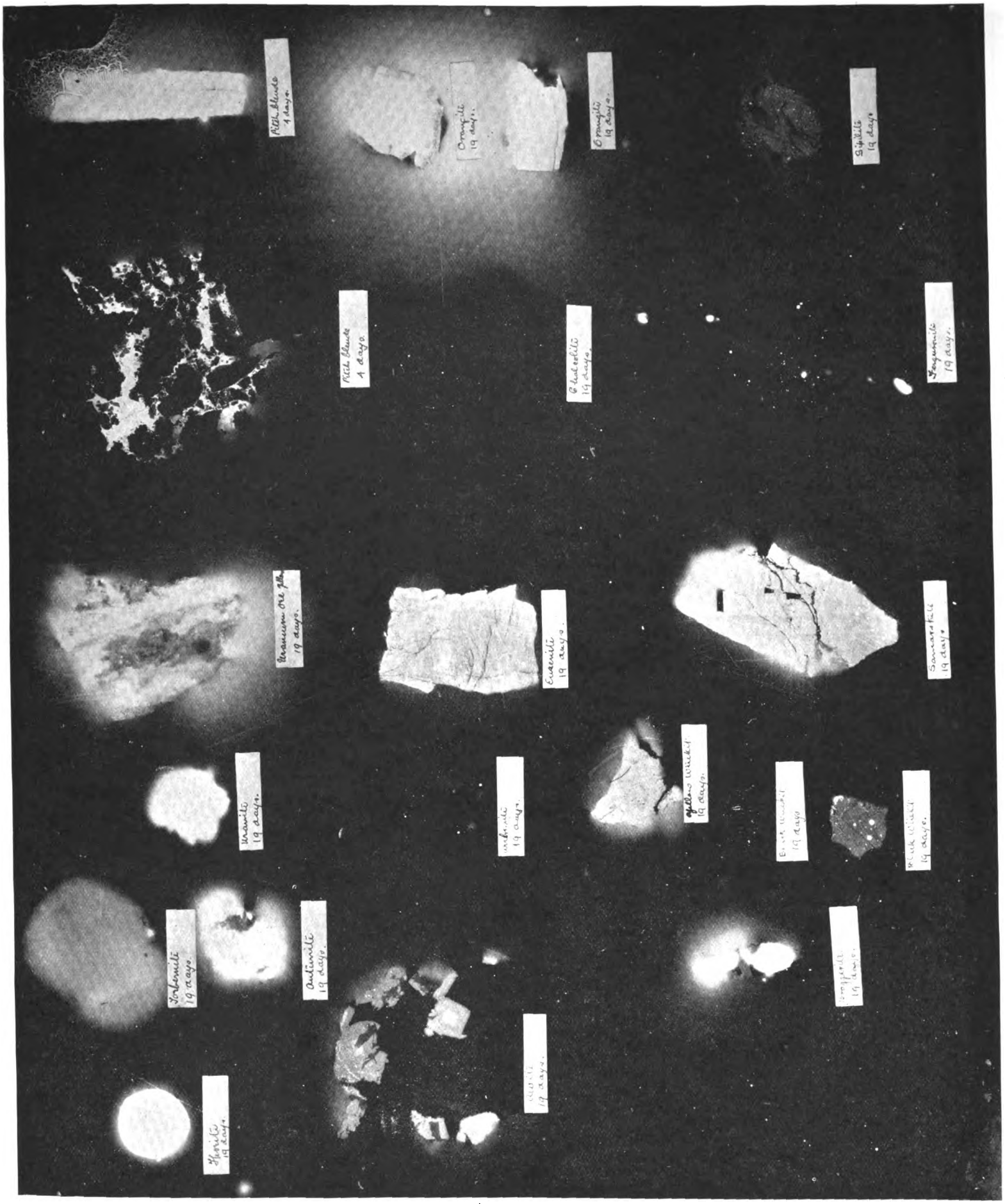
tions. They render air a conductor and act strongly on a photographic plate. These are the positively electrified atoms. Their mass is enormous in comparison with that of the electrons.

A third kind of emanation is also produced by radium. Besides the highly penetrating rays which are deflected by a magnet, there are other very penetrating rays which are not at all affected by magnetism. These always accompany the other emanations, and are Rontgen rays —ether vibrations—produced as secondary phenomena by the sudden arrest of velocity of the electrons by solid matter, producing a series of Stokesian "pulses" or explosive ether waves shot into space. These rays chiefly affect a barium platinocyanide screen, and only in a much feebler degree zinc sulphide.

Both Rontgen rays and electrons act on a photographic plate and produce images of metal and other substances enclosed in wood and leather, and shadows of bodies on a barium platinocyanide screen. Electrons are much less penetrating than Rontgen rays, and will not, for instance, show easily the bones of the hand. A photograph of a closed case of instruments is taken by the radium emanations in three days, and one of the same case by Rontgen rays in three minutes. The resemblance between the two pictures is slight, and the differences great.



Auto Radiographs of Radio-active Minerals.

From a Photograph lent by Sir William Crookes, F.R.S.

The action of these emanations on phosphorescent screens is different. The deflectable emanations affect a screen of barium platinocyanide strongly, but one of Sidot's zinc sulphide only slightly. On the other hand, the heavy, massive, non-deflectable positive atoms affect the zinc sulphide screen strongly, and the barium platinocyanide screen in a much less degree.

If a solid piece of radium nitrate is brought near the screen, and the surface examined with a pocket lens magnifying about 20 diameters, scintillating spots are seen to be sparsely scattered over the

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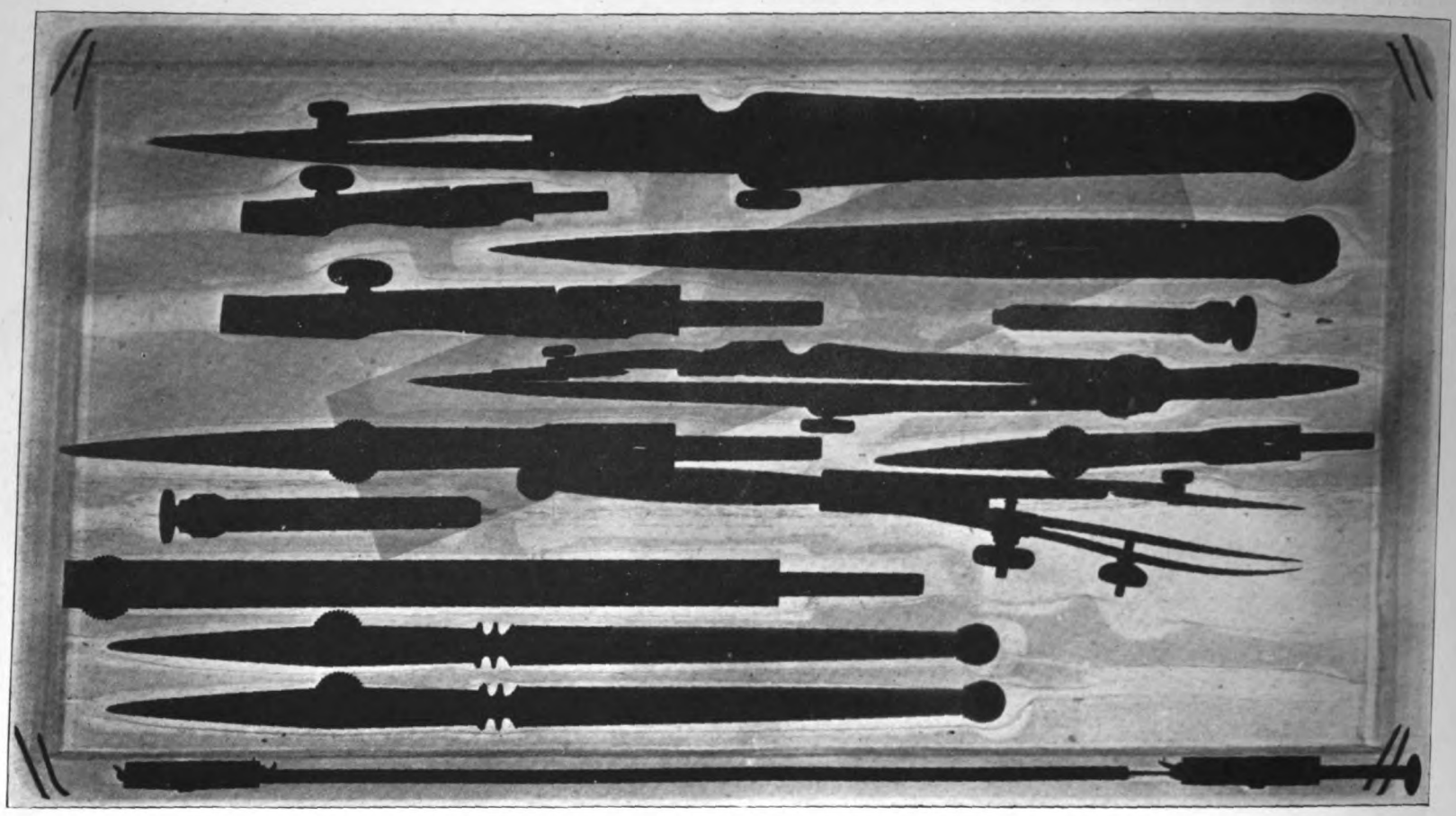
surface. On bringing the radium nearer the screen the scintillations become more numerous and brighter, until when close together the flashes follow each other so quickly that the surface looks like a turbulent luminous sea.

It remains to explain briefly the accompanying photographs, which have been lent us by the extreme kindness of Sir William Crookes. The largest one is the reproduction of a sensitized plate, in which various radio-active minerals have been allowed to impress their own



Radiograph of a closed box of Mathematical Instruments taken by Rontgen Rays.

It seems probable that in these phenomena we are actually witnessing the bombardment of the screen by the positive atoms hurled off by radium with a velocity of the order of that of light; each scintillation rendering visible an impact on the screen, and becoming apparent only by the enormous extent of lateral disturbance produced by its impact. Just as individual drops of rain falling on a still pool are not seen as such, but by reason of the splash they make on impact, and the ripples and waves they produce in ever-widening circles.

radiographs by contact. The following is a list of radio-active minerals, the most active heading the list. 1, Pitch blende; 2, Uranite; 3, Autunite; 4, Orangite; 5, Thorite; 6, Euxenite; 7, Samarskite; 8, Alvite; 9, Braggerite; 10, Monazite; 11, Xenotine;

The same box of Mathematical Instruments with a Radiograph taken by the Emanations of Radium.

12, Arrhenite; 13, Sipilite; 14, Fergusonite; 15, Chalcolite; 16, Hielmite. They were exposed in the plate for varying periods, the more active for only four days. The halo-like appearance is noticeable around some of the impressions. In the tryptich photograph of the

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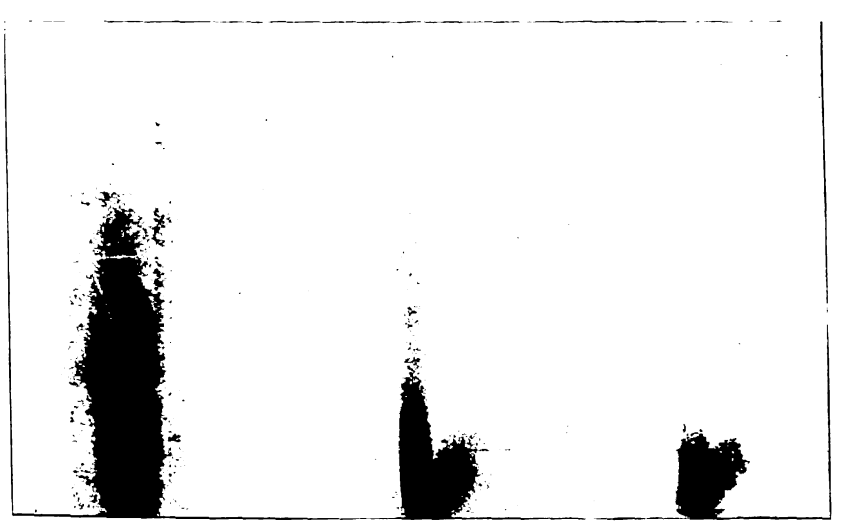
effects of an electro magnet on the rays—the first photograph is with the current off; the second with the current on, showing the deflection of some of the emanations, and the third with the heavy atomic emanations shut off by a mica screen. In this instance the magnet deflects a larger proportion of the rays.

Two explanations have been offered of the perpetual energy of radium. It has been suggested both by Sir William Crookes and Dr. Johnstone Stoney, that perhaps some bodies of high atomic weight (such as radium) might be able to draw on the stores of energy locked up in the molecular motions of quiescent air. "I suggested* that the atomic structure of radio-active bodies was such as to enable them to throw off the slow-moving molecules of the air with little exchange of energy, while the quick-moving missiles would be arrested, with their energy reduced and that of the target correspondingly increased. (A similar sifting of the swift-moving molecules is common enough, and is effected by liquids whenever they evaporate into free air.) The energy thus gained by the radio-active body would raise its temperature, while the surrounding air would get cooler. I suggested that the energy thus gained by the radio-active body was employed partly in dissociating some of the gaseous molecules (or in inducing some other condition which would have the effect of rendering the neighbouring air a conductor of electricity) and partly in originating undulations through the ether, which, as they take their rise in phenomena so disconnected as the impacts of molecules, must furnish a large contingent of Stokesian pulses of short wave-length. The shortness in the case of these waves appears to approach, without attaining, the extreme shortness of ordinary Rontgen rays. Although the fact of emission of heat by radium is in itself sufficiently remarkable, this heat is probably only a small portion of the energy radium is constantly sending into space. It is at the same time hurling off material particles which reveal their impact on a screen by luminous scintillations. Stop these by a glass or mica screen and torrents of Rontgen rays still pour out from a few milligrammes of radium salt, in quantity to exhibit to a company all the phenomena of Rontgen rays." It has been objected to this theory that when (for instance) radium was shut up in a block of ice, it could not be deriving its energy from the air. But Dr. Johnstone Stoney has pointed out that the same interaction might be, and probably is, going on at the surfaces of liquids and possibly of solids.



a. b. c.

The Emanations of Radium.

(a) With no electro magnetic field.
(b) Electro magnet deflecting part of the rays.
(c) Electro magnet deflecting a greater proportion of the rays when the atoms are shut off by a plate of mica.

The alternative theory is that which is based on the experiments of Professors Rutherford and Soddy. It is that the atom of radium is not stable under all conditions, and that among the large number of atoms contained in any specimen of radium there are a few which are in the condition where stability ceases, and which pass into some other configuration, giving out as they do a large quantity of energy. "Consider a case where the masses of the planets and their periods were so adjusted that they were fated for an instant in their existence to come all together in conjunction at the same time, so that a position of instability resulted. That system would at that instant suddenly disintegrate. Some parts fly out into space by virtue of their own proper motion, the rest reform into smaller systems. For æons the system might have remained in motion to all appearance as stable as our own solar system, but none the less its period as a single system in the universe is finite. . . . . Suppose that the thorium (or radium) atom was a similar system, what would be the result? Out of the myriads of atoms that go to make a single grain of radium, several, if not several millions, might break up every second in this way, and yet, the total number being so great, the process might go on for millions of years before all, or any considerable part, were changed. If, as each atom disintegrated, a ray or rays were suddenly emitted, the facts of radio-activity as at present known would be explained."

This theory, we have reason to believe, has commended itself as plausible to some of the greatest of chemists. But we may fitly conclude this article by quoting the modest opinion of one of the greatest of them—that possibly both explanations are wide of the real truth, though that of Professors Rutherford and Soddy is the one which holds out the greater attractions; but that what we want still most is further investigation.

* This is a reference to Sir William Crookes' Presidential address to the British Association in 1898.

Action of Gelatine upon Glass.

IN a paper read before the Académie des Sciences M. Cailletet describes the action of gelatine upon glass and other surfaces. When a glass object is covered with a thick layer of strong glue, the latter adheres strongly when wet, but upon drying it may be detached and carries with it glass scales of different thicknesses, which have been lifted from the surface. The glass which is thus treated presents a surface whose designs resemble those of frost on a window-pane, and have a decorative effect.

M. Cailletet made experiments with gelatine upon different substances, and found that tempered glass was easily attacked, as well as Iceland spar, polished marble, fluorspar, and other bodies. A sample of quartz cut parallel to the axis of the crystal was covered with two layers of fish-glue; after drying it was found that the surface was attacked and showed a series of striæ which were parallel, rectilinear, and ran close together, while in the case of glass the striæ were curved. When certain salts were dissolved in the gelatine, namely, those which were easily crystallized and had no action, there was produced on the glass a series of engraved designs which had a crystalline appearance. Thus a solution of strong glue containing 6 per cent. of alum gave very fine designs somewhat resembling moss in appearance; other salts such as hyposulphite of soda, nitrate and chlorate of potash, will produce analogous forms.

M. Cailletet told of the strong mechanical action exerted by a layer of gelatine when drying. If a sheet of cardboard, lead, or even wire-gauze is covered with a gelatine solution the surfaces are seen to curve into the form of a cylinder as the gelatine contracts. Upon thin glass the effect is striking; when a layer of strong glue is spread upon a cylindrical vessel of thin glass the effort which it exerts when drying is sufficient to break the vessel with explosion. When a plate of thick glass covered with gelatine is examined by polarized light a powerful mechanical strain is observed in the glass, and the value of this effect could no doubt be measured.

Kite Flying Competition.

THE revised rules for the forthcoming kite competition have now been published by the Aëronautical Society.

They are as follows:—

1. The Competition is for the highest flight attained by a single kite beyond 3,000 feet.
2. Duration of flight to be one hour, and kites must be sustained in the air during this period.
3. Each kite must carry a weight of two pounds. The weight to be placed within 100 feet of the kite.
4. The height to be determined trigonometrically from the ground.
5. The Competition is open to all approved by the Council of the Aëronautical Society of Great Britain, without limit of form of apparatus, and each Competitor must provide his own apparatus, winding gear, etc.
6. Each Competitor is to be held responsible for any damage or accident that might occur to or by means of his apparatus.
7. Members of the Aëronautical Society of Great Britain will have to pay no entrance fee, but for non-members there will be an entrance fee of half-a-guinea.
8. Not less than two Competitors can enter for the Competition.
9. The Jury will have the decision whether the Medal is to be awarded.
10. The decision of the Jury must be accepted as final.

In issuing these General Rules the Council reserve to themselves the right of making any additional regulation which may tend to facilitate the carrying out of the Competition.

Amongst those who have kindly consented to act on the Jury are—Mr. C. V. Boys, F.R.S., Mr. E. P. Frost, J.P., D.L., Sir Hiram Maxim, Dr. Hugh Robert Mill, LL.D., F.R.G.S., Dr. William Napier Shaw, F.R.S., Mr. Eric Stuart Bruce, M.A.

Members of the Aëronautical Society of Great Britain and others who wish to take part in the above Competition should communicate with the Honorary Secretary of the Aëronautical Society of Great Britain, 53, Victoria Street, Westminster, London, S.W.

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Kew New Bridge.

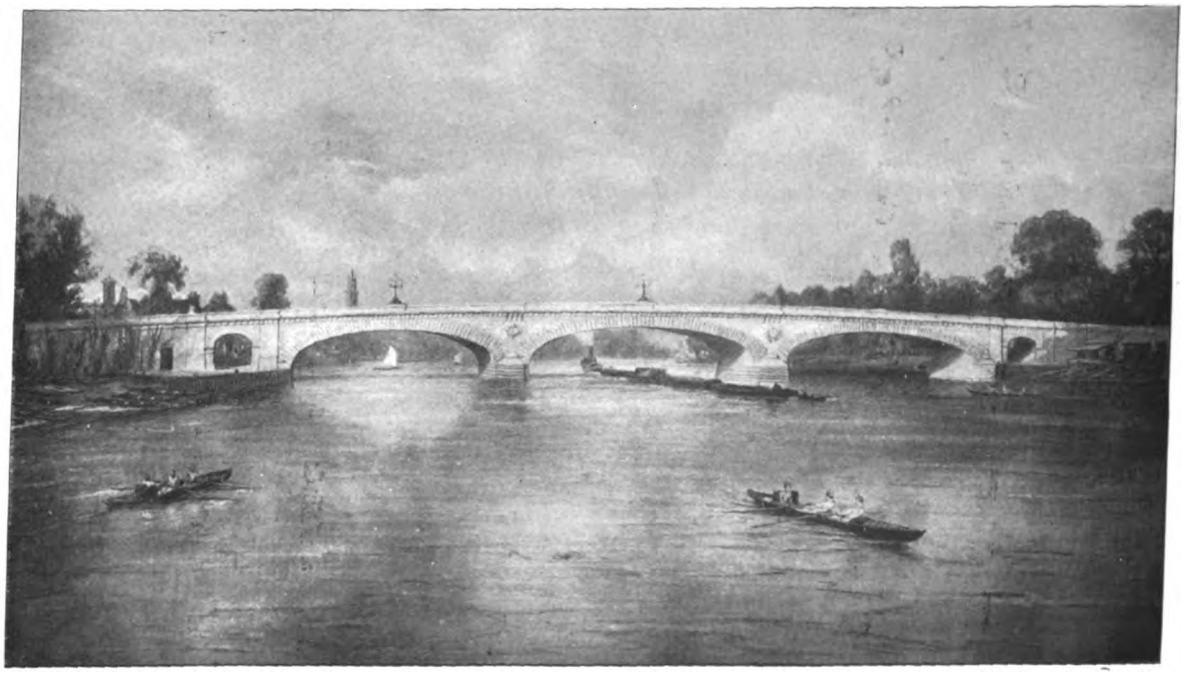
IN adjusting the coping stone on the new bridge at Kew, which bears his name, the King justly remarked that the bridge was one "not the least beautiful" of those that span the Thames. The King Edward VII Bridge is, moreover, one of the most convenient and one of the finest from an engineering point of view. In total length the bridge, with its approaches, is 1,182 ft. long. The three river spans, true ellipses in configuration, are not all the same size. The middle span—the widest—is 133 ft., the two side spans are 116 ft. 6 ins. each. In width it is 55 ft. between parapets, and the headway of the centre span at the highest point is 20 ft. above Trinity high-water mark.

PRELIMINARIES.

From beginning to end the bridge has taken about four years to build, but this includes the putting up of a temporary bridge and the pulling down of the old one. The temporary bridge was of wood, carried on timber piles and trestles, and no one, except, perhaps, those who built it, could possibly find in it anything to admire. It was dusty and depressing, and nobody lingered on it. It served its purpose, however, and one must admit that its long gradients, while they prolonged the time that one was obliged to spend on crossing its unlovely roadway, were, on the whole, better for the horses than the beautiful but steep lines of Old Kew Bridge. Moreover, its three openings for navigation of 75 ft., 40 ft., and 50 ft. respectively, were convenient, and the best compliment that one can pay it is to remember that after being in use for three and a half years it was still in good condition. The temporary bridge was opened in October, 1899, six months after it had been begun. Then began the work of pulling down Old Kew Bridge. A cableway, across the river, was built, and this 550-ft. span, carrying on its trolley a working load of over five tons, was of the greatest service in removing the parapets, roadway, and felling above the arches, as well as in putting timbering under the arches. The hardest part of the work of demolition, however, was in removing the lower portion of the old piers and pier timber platforms, which, if left in, would have been in the way of both the temporary bridge and the work on the permanent one. Sometimes the masonry of the old bridge was used as a dam while the removal went on, but divers had also to be employed. The foundations of the old bridge, when at last got at, were found to consist of timber platforms, each of about 700 square feet, laid on the London clay. The masonry had evidently been built up to some height on these platforms, and they had then been floated into position and sunk at low water. It was not until November, 1901, that the sixth and last of these platforms was got up and floated out.

CONSTRUCTION.

Operations for the new bridge began on the Middlesex side. Piles were driven in so as to form a coffer-dam, or a kind of sunken cistern, out of the bottom of which the water was pumped and the clay was excavated. The whole area of the abutments having been excavated, cement concrete was filled in, and the foundations for the land arches were laid. The foundations for the river pires were next undertaken, beginning with that nearest to the Middlesex shore. The method was similar to that just described in the case of the land arches, but the excavations were much deeper, and the concrete bases more extensive and more solid. Excavation, for example, was taken out to a depth of sixteen feet below the bed of the river, or fourteen feet into the London clay. The cement concrete for the foundation of the piers was 11 ft. 9 ins. deep, and the dimensions of the base are 107 ft. in length—that is to say, along the course of the river—and 39 ft. in width. In length, therefore, these concrete bases are double the width of the bridge above them. From these piers the arches—of steel—had to be thrown. It was necessary for several reasons, of which questions of navigation were one, to begin by constructing the arch of steel. When this was done the steel centreing was superseded by masonry, and the piers finished. One might say that the stone bridge was built round this steel skeleton, replacing it at last, as a finished pen and ink drawing supersedes the pencil marks of its first rough sketch.



The King Edward VII. Bridge at Kew.
From a drawing in the possession of Cuthbert A. Brereton, Esq., M.Inst.C.E.

Variable Stars.

A NEW variable of the Algol type, 4.1903 Draconis, has been discovered by Madame Ceraski. This has a great range of variability in a short period, varying as much as 2.4 magnitudes in 1 day 8 hrs. 34.7 mins.

During June one of the most extraordinary of variable stars, β Lyræ, is suitable for observation. It is remarkable as having two periods of maximum and minimum brightness. During a period of nearly 13 days, it twice attains a magnitude of 3.4, but, what is still more peculiar, in the intervals, it decreases alternately to 3.8 and 4.4 magnitude. The variability in many stars, such as in Algol, can be accounted for by the interposition of a dark body revolving round it in an orbit on the same plane as the observer. In the case of β Lyræ however, other causes must be looked for. It is generally supposed that there are two bright stars comparatively close together, which eclipse one another, these, too, being of different composition and differing in brightness. Spectroscopic observation tends to confirm this idea, but there must also be some other circumstances to account for all that is observed. It has been suggested that there may be three stars revolving about one another, though for various reasons this seems improbable. Here is one of those many mysteries of the heavens which awaits explanation.

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Centenary Celebration of the Atomic Theory.

A Retrospect.

THE City of Manchester is inseparably identified with the name of the illustrious John Dalton, the prophet of a conception in chemistry now an integral part of scientific philosophy.

The Literary and Philosophical Society of Manchester, an institution which claims more than a century and a quarter of vigorous existence, was also closely linked for fifty years with the record of Dalton's life and illuminating labours. He was elected a member in 1794, was for several years secretary, and acted as president from 1817 till 1844. Further, the Society enjoys the unique distinction of having received and published his world-known chemical enunciation.

Alive to the dignity of the connection, the Society lately resolved to celebrate the arrival of the centenary year of the announcement of Dalton's atomic theory by a series of scientific *réunions* and festivities. These were arranged for May 19-20, and comprised a lecture under the Wilde Trust, by Prof. F. W. Clarke, of the Columbian University, Washington, on "The Atomic Theory"; a special meeting of the Victoria University for the conferment of honorary degrees, and a civic banquet, presided over by Manchester's chief magistrate—the official testimony to the Municipality's share in the commemoration.

The centenary naturally suggests some notice, however brief, recalling the circumstances of Dalton's upbringing and his achievements in science. He was a native of Eaglesfield, Cumberland, and was born about September 6, 1766—the exact date of his birth, it seems, having never been ascertained. His father, a member of the Society of Friends, was a humble hand-loom weaver, and the son was early bred to the needs of a work-a-day life. As a young lad at Eaglesfield he was fortunate enough to receive the patronage and friendship of one Elihu Robinson, a man of discernment and parts, moreover a meteorologist. Under his influence and teaching, assisted by the primary schools of the neighbourhood, much sound knowledge was laid up, and Dalton acquired a zeal for learning and for the study of natural phenomena that well requited his instructor's efforts. At twelve the pupil turned master and taught in a school of his own establishment. At fifteen he migrated to Kendal, finding employment there as a teacher in a boarding school, an avocation followed under many changeful circumstances for several years. The period at Kendal was, however, fruitfully occupied, and here it was that he began daily meteorological observations and experimental work in the physical sciences, though his laboratory equipment, if such it could be called, was of the simplest character. In 1793 a larger sphere presented itself in a tutorship in mathematics and natural philosophy in the Manchester Academy, where for six years the embryo philosopher taught a comprehensive curriculum, comprising, it is recorded, mathematics, mechanics, geometry, bookkeeping, natural philosophy, and chemistry. Subsequently he embraced private tuition, his leisure time being devoted to scientific researches; and henceforth he lived and worked in Manchester, without material break, until his death in 1844.

Dalton's earliest scientific enquiries were not made in chemistry proper; they related to the registration and discussion of meteorological data and the experimental study of atmospheric phenomena. His "Meteorological Observations and Essays" was prepared at Kendal, and published in the year that he took up residence at Manchester, a work which reveals keen appreciation of the book of Nature and her varied operations, and it may be said that the sound philosophical principles that underlay and formed the bed-rock of these primary investigations in meteorology and allied subjects insensibly found extension in the pregnant conclusion of the atomic hypothesis in chemistry. In 1800 he wrote a paper "On the Heat and Cold Produced by the Mechanical Condensation and Rarefaction of Air," which contained approximations of the amount of heat evolved by compression, and heat absorbed by dilatation. Sir H. Roscoe hazards the guess that Joule may possibly have been prompted by this paper to construct the equivalency of heat and mechanical energy. The following year a classical contribution appeared on the constitution of mixed gases, succeeded also by others relating to the chemical and physical properties of gases. Limits of space forbid mention of the intermediate sequence of work, but we arrive at a paper which nine persons listened to in the apartments of the Literary and Philosophical Society, on October 21, 1803, entitled "On the Absorption of Gases by Water and other Liquids." In this quiet fashion was ushered in nothing less than the atomic theory of chemistry, for whoever turns to the Manchester Memoirs, Vol. I. (Second series) will find at page 286 the following:

> Why does water not admit its bulk of every kind of gas alike? . . . I am nearly persuaded that the circumstance depends upon the weight and number of the ultimate particles of the several gases. . . . An inquiry into the relative weights of the ultimate particles of bodies is a subject, as far as I know, entirely new; I have lately been prosecuting the inquiry with remarkable success. The principle cannot be entered upon in this paper; but I shall subjoin the results as far as they appear to be ascertained by experiments.

Then follows a "Table of the relative weights of the ultimate particles of gaseous and other bodies," beginning "Hydrogen, 1." Although read in 1803, this celebrated communication, which ever since has commanded the admiration of the world of science, was not published until 1805.

Dalton was elected a Fellow of the Royal Society in 1822, and he was awarded their Royal Medal in 1826. The Society's Copley Medal, it may be noted, universally recognised as the blue riband of English science, was never awarded to Dalton, a circumstance which points to the fact that his contemporaries did not realise the far-reaching quality of his message to chemical science, and it is of curious interest to observe that the gift of that medal for the year 1803 was made to Richard Chevenix "for his various chemical papers printed in the Philosophical Transactions." The Royal Society possesses a portrait in oils of Dalton, executed from life a few years before his death, and presented by a memorial committee instituted at Manchester.

This brief review may be fittingly closed by a latter-day utterance of the philosopher. "If I have succeeded better than many who surround me, it has been chiefly—nay, I may say, almost solely—from unwearied assiduity. It is not so much from any superior genius that one man possesses over another, but more from attention to study and perseverance in the objects before them that some men rise to greater eminence than others."

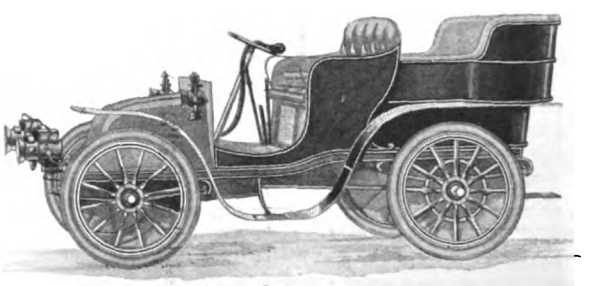
Is the Sun Inhabited?

THERE have been many and various hypotheses brought forward as to the possibility of some of the planets being habitable to human beings similar to those peopling this earth. But a still more startling and ingenious theory has lately been published by an American astronomer. Mr. Young, who asserts that the sun itself may be a land like our own. The idea is that the solid globe is surrounded by an atmosphere which is a nonconductor of electricity and heat. The sun, according to this imaginative theorist, is a centre of electric force. Converging streams of electricity are ever flowing to this centre, but on meeting with the non-conducting atmosphere become changed into a brilliant discharge, which gives the appearance of a solid incandescent body. Away in the centre of this brilliant crust, and far separated from it by the non-conducting atmosphere, lies a beautiful planet having all the most desirable characteristics of our own earth. But it is only very rarely that we can obtain a glimpse of this abode of bliss, or its strange inhabitants, if they exist, set eyes on our little planet. Then it is through the aperture or rift in the luminous clouds which we call a sun-spot.

The Characteristics of Motor Cars:

The Wilson-Pilcher.

AMONG the large number of different types of motor cars are to be found several possessing distinctive features which, while conferring special benefits, are often lost sight of in considering the whole car. We may take as an instance the Wilson-Pilcher machine, which, though not, perhaps, so well known as many others, is one possessing quite a number of very good and novel points.



One of the most noticeable features of this, as compared to other petrol cars, is the noiselessness and absence of vibration while running. This is a very important characteristic, as not only does it add greatly to the comfort in using the car, but smoothness of running must also indicate less wear and tear on all parts.

This feature is due to a variety of causes. First we may mention that the engines and change-speed-gear are quite separate from the body of the car. The channel steel frame, to which the wheel-axles are rigidly fixed, is arched in front and rear, and the engines are loosely hung from pivots in these arches, and kept in place by springs.

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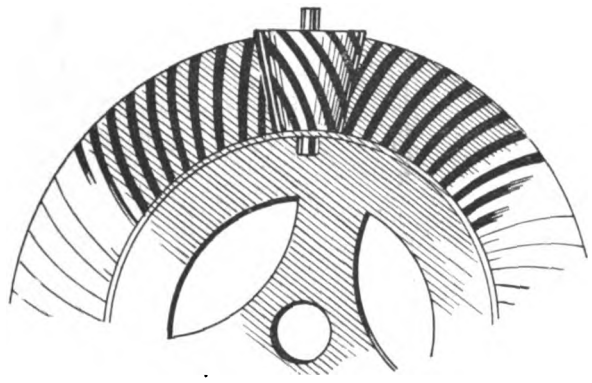
By this arrangement the bearings cannot be thrown out of line by the jerks resulting from passing over irregularities of the road. They can

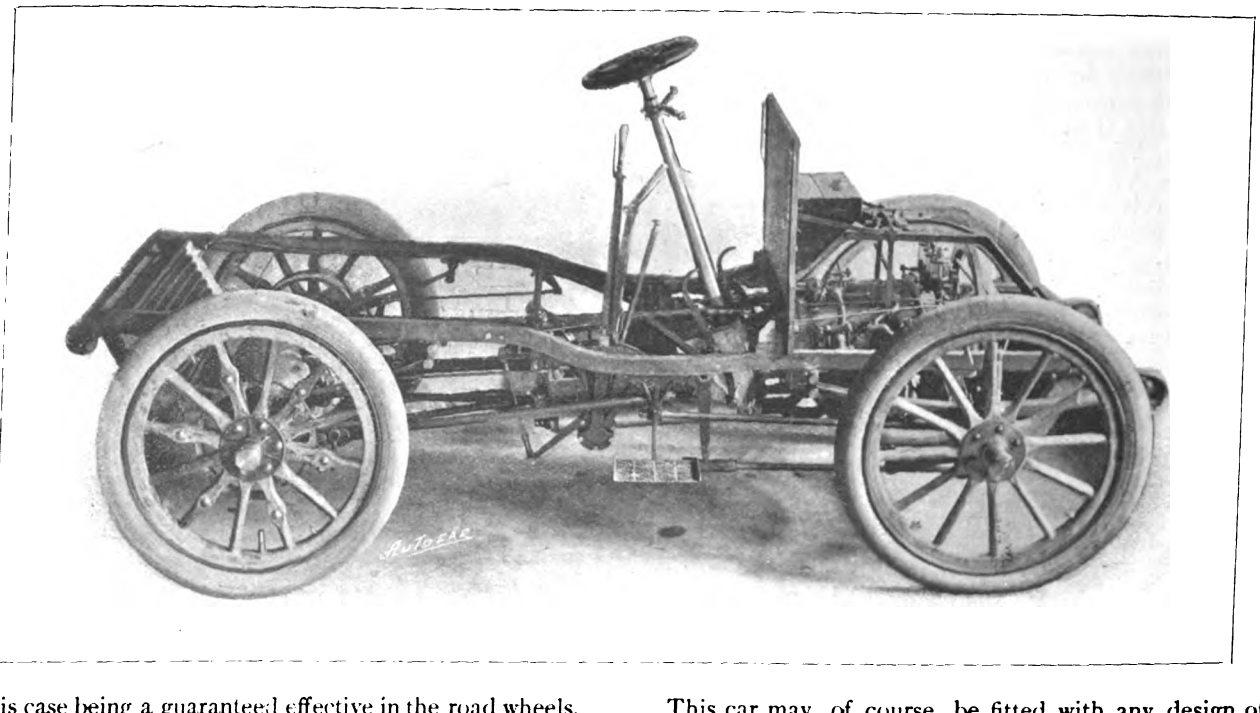


therefore be made long and of good fit. The latest pattern of car is fitted with a 4-cylinder horizontal engine of 10-horse power; the horse-power in this case being a guaranteed effective in the road wheels, and not the nominal of the motor as is usually mentioned. The engine shaft is rigidly connected to two patent reduction gears, and a universally-jointed longitudinal shaft conveys the power to the bevel wheels gearing with the driving axle.

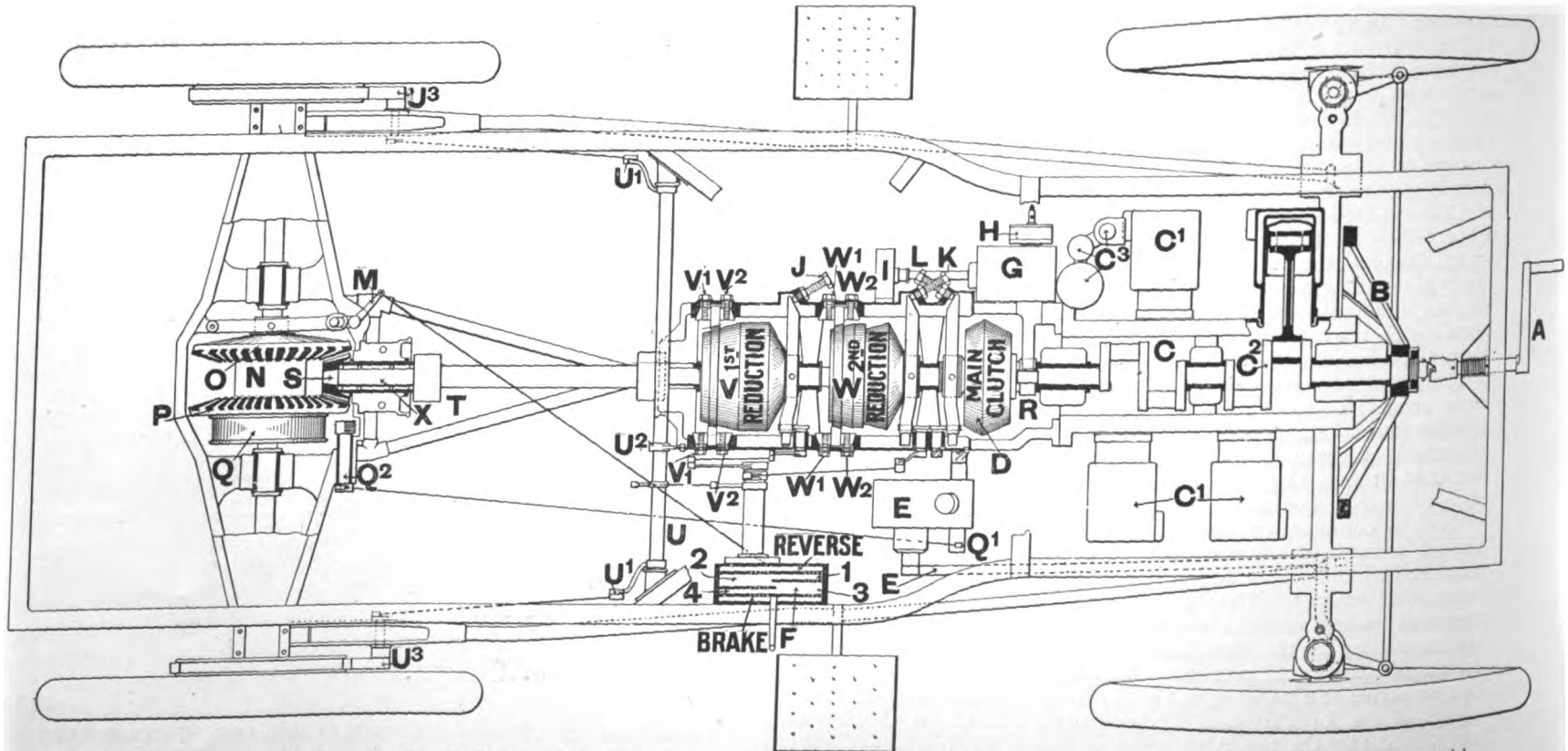
These reduction gears are another special feature, and have the following advantages: The gear wheels are always in mesh, and yet are never running idle; wear and noise are thus reduced to a minimum. On changing the gear no shock is experienced since the change is effected without throwing out the clutch or in any way taking the drive off the car. On the highest speed no gear wheels are in motion except the main bevel, so that a high efficiency is secured. These change gears are each worked by a separate friction clutch. Another convenience is that the four gears are all controlled by one lever.

The toothed gearing in this and other parts of the machine is another novelty. It consists of what is known as "skew bevel wheels," or a bevel with curved teeth, and confers several advantages. They are very noiseless, they wear well, and are not liable to rattle when worn; and they are much stronger than ordinary toothed wheels.

Among other novel features is a special electric ignition device, in which a single trembler serves for igniting all four cylinders. A patent commutator is used in connection with this.



This car may, of course, be fitted with any design of body. The chassis and all parts of the engine are made in the works of the firm in Westminster.



A Starting Gear.
B Fly-wheel of Motor.
C Motor Crank Chamber.
C¹ Motor Cylinders.
C² Motor Crank.
C³ Carburetter.
D Main Clutch.
EE Steering Gear and Rods to Front Wheels.
F Speed Changing Levers and Brake Handle.
G Oil Pump to Lubricators.
H Commutator.
I Water Pump.
J Adjusting Screw for 1st Reduction Gear.
K Adjusting Screw for 2nd Reduction Gear.
L Adjusting Screw for Main Clutch]
M Reversing Gear.
N Compensating Gear
O Forward Bevel Drive.
P Backward Bevel Drive.
Q Internal Brake Drum.
Q¹ Foot Lever working same.
Q² Connecting Levers to same
R Skew Gear Drive to Pumps.
S Maindrive Bevel Pinion.
T Universal Joint Shaft.
U Brake Shaft. [Brakes
U¹ Levers working Road Wheel
U² Automatic Clutch Release with Brake Action.
U³ Road Wheel Brake Drums.
V First Reduction Gear.
V¹ V² Outer Friction Ring Adjustment on V Gear.
W Second Reduction Gear
W¹ W² Outer Friction Ring Adjustment on W Gear.
X Maindrive Roller Bearing.

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Astronomical Notes for June

THE SUN.

THE Sun rises on the 1st at 3 h. 51 m. a.m., and sets at 8 h. 3 m. p.m. There is no *real* night in this month, but either daylight or twilight. The Sun's apparent declination at noon on this date will be 21° 55′ 50″ N., with an hourly variation of 21″.29, his R.A. being 4 h. 32 m. 38 s., the hourly variation of which amounts to 10″.22.

Sunspot activity has somewhat subsided, though small spots and faculæ are visible from time to time.

THE MOON.

The Moon reaches her first quarter on the 2nd, at 1 h. 24 m. p.m., and is full on the 10th, at 3 h. 8 m. a.m., her last quarter being attained by the 18th, at 6 h. 44 m. a.m.; she will be new on the 25th at 6 h. 11 m. a.m. Our satellite will be in apogee on the 13th, and in perigee on the 26th.

When the Moon is at her first quarter she will *set* at 0 h. 13 m. a.m.; when full she will *rise* at 8 h. 17 m. p.m.; and at the time of her last quarter she will *south* at 6 h. 0 m. a.m. At full our satellite will be at Southern Declination 18° 32′ 45″, and Right Ascension 17 h. 28 m. 41 s., whilst at new, her N.D. will be 18° 19′ 29″ and R.A. 6 h. 26 m. 0 s.

Occultations of stars suitable for the ordinary observer occur on the 27th, one being that of 60 Cancri (magnitude 5.7), the disappearance taking place at 8 h. 42 m. p.m. at 159° from the true north point, and the reappearance 32 minutes later at 234° from the T.N.P.; and the other being of *a* Cancri (magnitude 4.3), the disappearance taking place at 9 h. 28 m. p.m., and the reappearance at 10 h. 5 m., being invisible at Greenwich, the Moon setting at 9 h. 40 m. p.m.

The Moon will be in *conjunction* with Mars on the 4th, Saturn on the 14th, Jupiter on the 18th, Mercury on the 23rd, and Venus on the 28th.

THE PLANETS.

At the beginning of the month Mercury will be too near the Sun for satisfactory observation. Towards its close, however, he may be seen as a "morning star," rising about an hour before the Sun. On the 30th his N.D. will be 19° 50′, which, being less than that of the Sun, will mitigate greatly the chances of observation by the ordinary amateur. His R.A. on the same date will be 4 h. 59 m. 33 s.

Venus is a very conspicuous object in our evening skies during June, setting in the north-north-west on the 4th at 11 h. 19 m. p.m., with N.D. 23° 14′, and R.A. 7 h. 53 m. 49 s. She is now nearing her greatest elongation *east*, and shows us an apparent diameter of 21″.6 by the end of the month.

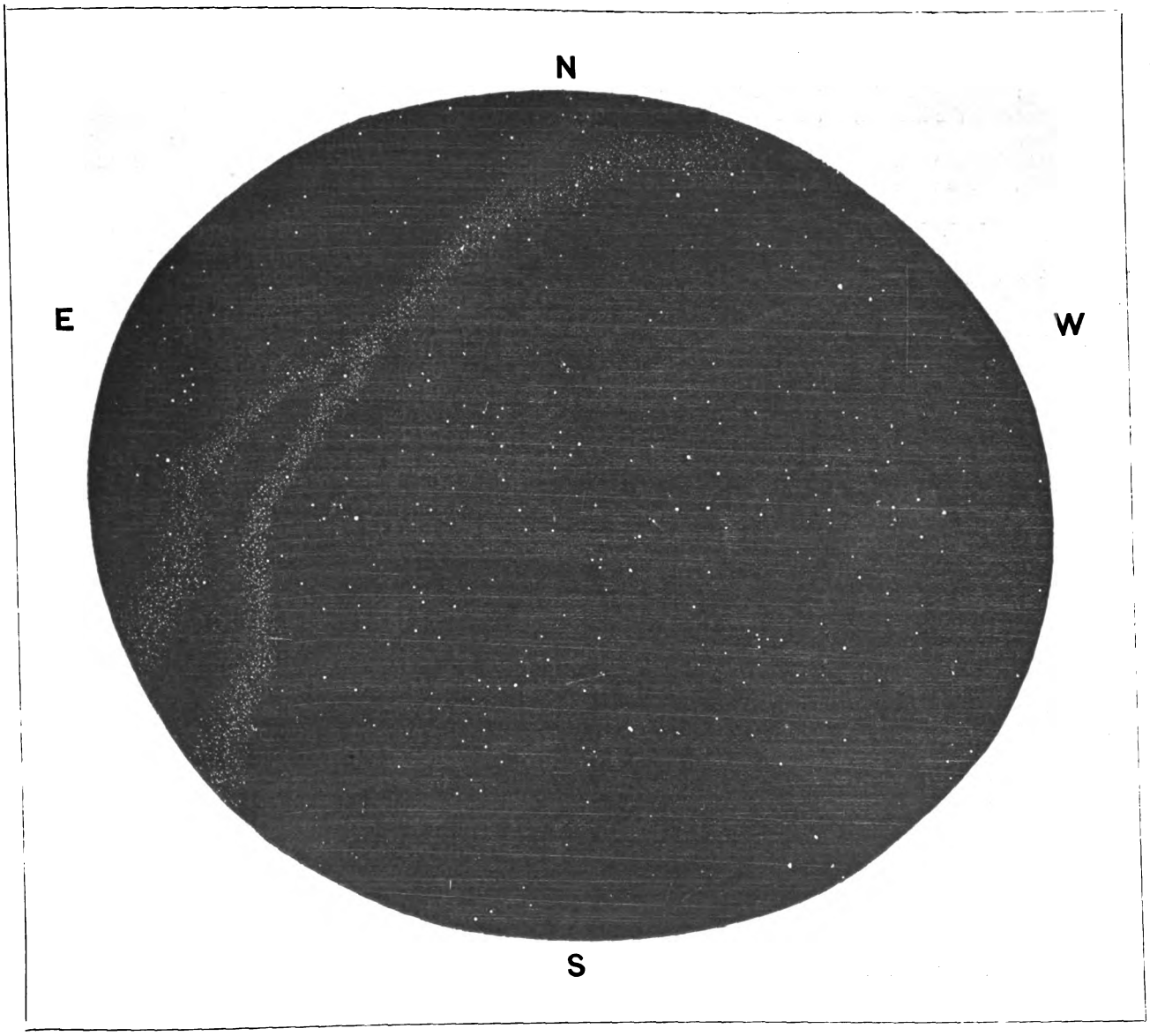
Mars, whose apparent diameter will be 9″.0 in the middle of the month, is but of little interest to the small telescopist, but as he is above the horizon for practically the whole of the amateur observer's "night"—*i.e.*, from sunset till midnight—some may find amusement in "discovering" imaginary "canals," etc.

By the close of the month the giant planet of our system (Jupiter) will rise half an hour before midnight, his S.D. on the 30th being 3° 55′ 17″.

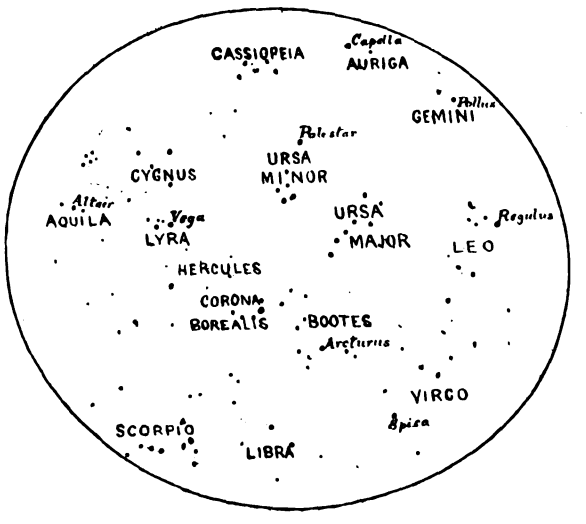
Saturn also becomes more favourably situated for the observer in the course of the month, this planet rising at 11 h. 10 m. p.m. on the 10th, and as early as 10 h. 7 m. p.m. by the 25th. His large southern declination (over 188), will, however, militate somewhat against his satisfactory observation.

Uranus, which still presents a disc 3″.7 in apparent diameter, comes into *opposition* with the Sun on the 15th. On the 20th the planet will rise at 7 h. 46 m. p.m., with S.D. 23° 25′ 51″, and R.A. 17 h. 31 m. 29 s. It will be seen from this that the otherwise favourable position of this planet is unfortunately practically negatived by his considerable southern declination.

Juno is still favourably situated, passing the meridian at about 10 h. p.m. at the middle of the month, with S.D. of 2° 17′ 47″, and R.A. of 15 h. 46 m. 1 s. She will be near to the star μ Serpentis on the 25th.



The Heavens in June.



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THE CONSTELLATIONS.

On the 7th of the month at 10 h. p.m. Boötes, with its chief star of yellowish hue known as Arcturus, will be found almost on the meridian, immediately we elevate our gaze toward the southern skies. Directly following this constellation is that of Corona Borealis, with Alphecca, the brightest gem in the Crown. Libra is now also on the meridian, but nearer the horizon, whilst Virgo is just to the westward of the same point.

To the eastward is found Lyra, with Vega, higher up than last month, and apparently the "Eagle with the Lyre" (Lyra) is racing the Swan (Cygnus) in their steady march towards the meridian. Between Corona and the Lyre, Hercules will be found, and closer to the eastern horizon lie the constellations of Aquila, Delphinus, and the rest. Ursa Major is now declining towards the west, whilst the Lesser Bear stands on its hind legs due north. Further to the West the "Sickle of Leo" rapidly approaches the horizon, whilst the Twins are almost on the point of setting.

The map represents the face of the sky at 10 h. p.m. on June 1st, 9 h. p.m. in the middle of the month, and 8 h. p.m. at the end.

Wireless Telegraphy.

PROFESSOR FESSENDEN'S SYSTEM.

PROFESSOR FESSENDEN'S system is that which in the United States has competed with the De Forest Smythe system for adoption in the U. S. Navy. Except in matters of detail it falls into the category of Marconi systems; that is to say, it depends on inducing a large difference of potential at the spark-gap of the transmitter in order to obtain what we may metaphorically call a loud, explosive, or far-reaching discharge of etheric impulses; and its coherer is of the kind which when it is acted on by the reception of an etheric impulse actually "coheres." In other words, two wires are momentarily brought into contact by the action of the arriving electrons or etheric waves—whichever we may think them—and a current is allowed to flow through the contact in order to record a signal. But in order to obtain speed, Fessenden has eliminated the Morse registering device, and substituted the telephone receiver. This necessitates some form of a wave detector that is more rapid than the process of cohesion and decohesion. The Fessenden wave-detector is far more rapid in operation than a self-restoring coherer, and has the added advantage of utilising all the energy of the wave, whereas in ordinary coherers only that portion is used which is necessary to bring the potential to a certain critical value when cohesion takes place.

This device is based somewhat on the principle of a bolometer, but instead of having a large radiating or absorbing surface in proportion to its mass, the Fessenden detector is just the reverse; so that the conductor losses will exceed the radiation losses; the heat capacity is exceedingly small, so that an infinitesimal amount of energy is required to heat it. To obtain these effects in practice, a short loop of silver wire, having a diameter of 0·002 in., and having a platinum core 0·00006 in. in diameter is fastened to the leading-in wires, which are sealed in the glass bulb. The tip of the loop is immersed in nitric acid and the silver dissolved away, leaving the platinum exposed. To furthur decrease the loss of radiation by heat, the loop is enclosed in a silver shell, as shown. The bulb may be exhausted to further increase the sensitiveness of the detector.

In practice Professor Fessenden has been the inventor of many ingenious devices in order to increase the efficiency of his instruments—for instance, at the spark-gap compressed air is blown on the gap, in order to increase greatly the difference of potential between the points before the gap gives way and the spark springs across. By this means the explosion or spark is made of much greater intensity, while the oscillatory character of the discharge is preserved. The device is thus described: "In using this apparatus the terminals are adjusted to about ¼ inch apart when using a 12 inch sparking coil. By increasing the pressure the dialectric strength of the medium is increased, and the spark potential can be raised to almost any amount without any material loss in oscillatory power—whereas in air under ordinary pressure it is found that no matter how high the potential is raised practically no increase in efficiency is obtained higher than with a given spark length."

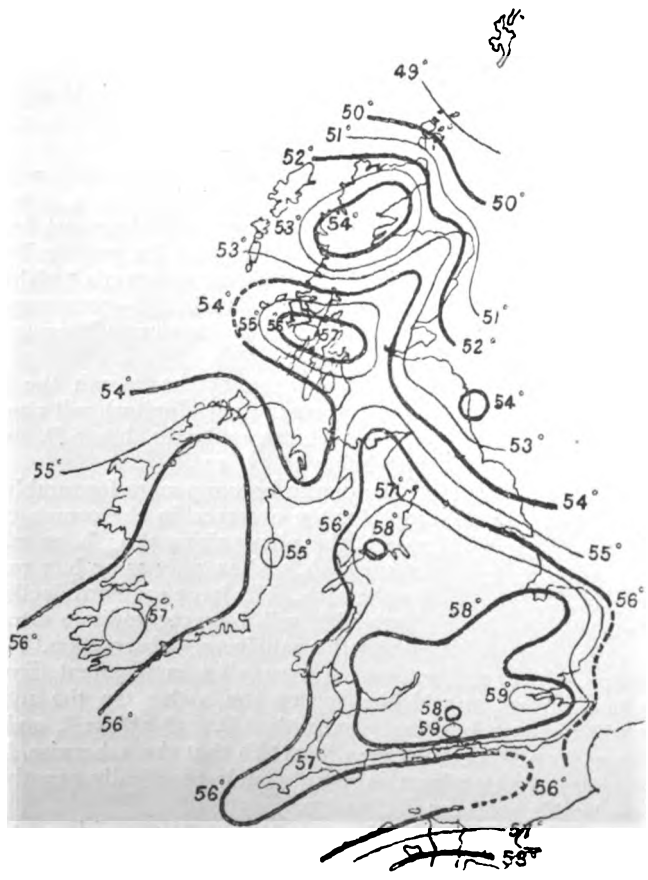
Similar ingenuity is displayed in the construction of the sending uprights, or aerials with their antennæ. Professor Fessenden remarks: "I have found that it is essential for the proper sending and receipt of these waves that the surface over which they are to travel should be highly conducting, more especially in the neighbourhood of the point where the waves are generated. I have found that this highly-conducting portion of the surface should extend to at least a distance from the origin equal to $\lambda/4$ of the wave in air, and in the direction toward the station to which it is desired to send the waves."

Another novel feature of the antenna and oscillator system is due to the discovery of Fessenden—that if electromagnetic waves were produced in a medium having a specific inductive capacity and permeability to electromagnetic waves greater than air, the height of the antenna may be considerably reduced, since "the periodicity of oscillation is decreased compared with that of the same antenna to be regulated by increasing the area of the antenna, and the latter by adding to the number of turns of wire connecting the vertical wire with the source of electromagnetic force."

One of the strongest points in Fessenden's apparatus is that by which he is enabled to send messages at an exceedingly high rate of speed—much higher than in the ordinary method of making and breaking the primary circuit.

LAST YEAR'S WEATHER.—JUNE, 1902.

DISTRIBUTION OF MEAN TEMPERATURE.



These readings are mostly rather below the mean average for 30 years.

RAINFALL.

In the Western and Northern Stations there was a slight deficiency, but in other parts there was mostly an excess over the average.

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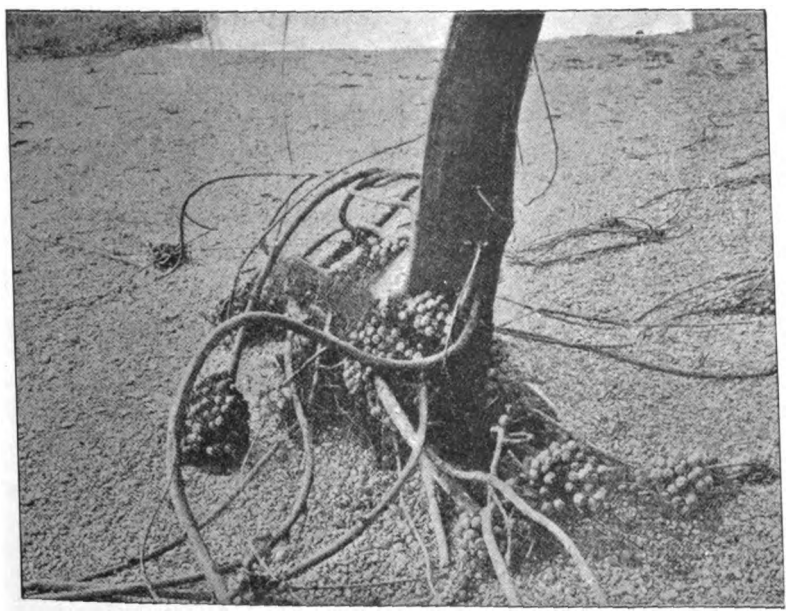
Cauliflorous Plants.

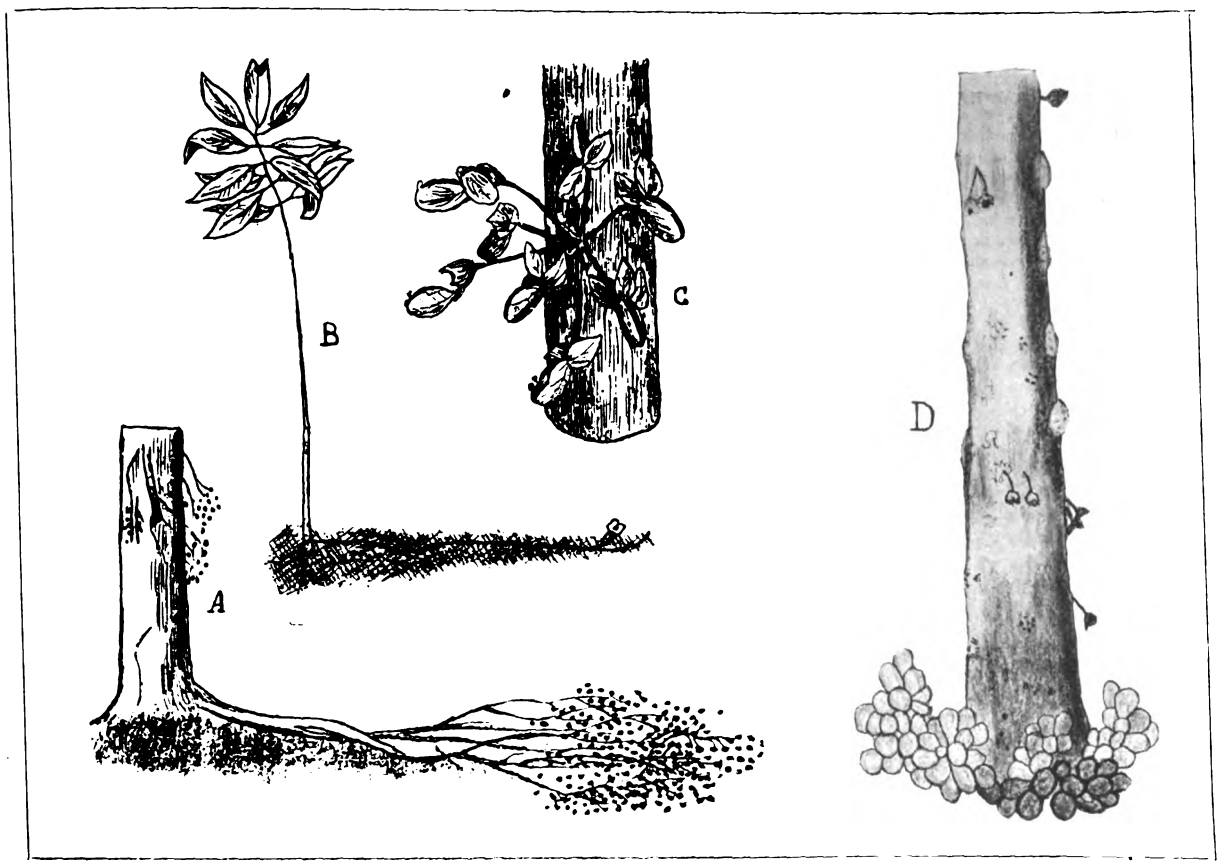
IT is scarcely possible to touch upon any essential feature in a plant's structure without finding that the species characteristic of the tropical regions of the earth differ more or less considerably from those of our parts. Thus with us it is customary for the flowers to be borne on the younger portions of the plant—generally on those shoots which also develop foliage leaves simultaneously—and we should, for instance, be very much surprised to find a horse-chestnut-tree bearing its flowers immediately on the main trunk or on one of the primary branches of the latter. In the forests of the tropics, however, this is not such a very rare occurrence, and the appearance presented by a plant of this type is frequently very unique. The phenomenon is due to the sprouting of small buds, which were formed at the same time as the old stem, bearing them, but which for many years remained in a dormant condition. Such dormant or resting buds, as they are called, are by no means confined to the tropics; in our part of the world the common trees develop large numbers of such resting-buds (in this case vegetative buds), and in the event of the main buds (which ordinarily develop into the branches), becoming damaged in any way, one or more of the former resume their activity and replace the damaged organ.



"Ficus Vrieseana," Mig., a cauliflorous plant of Java.

Plants, which thus bear their flowers in the older regions, are said to be cauliflorous. The flowers may either occur on the main stem only, or only on branches of the latter, or in both positions; and a considerable number of plants exist, which show a kind of intermediate stage between the normal and the cauliflorous condition. In these latter cases the flowers are borne on what are still relatively young branches or they occur at the now leafless base of shoots, which higher up still bear foliage leaves (*e.g.*, in the Mezereon of Europe). It is evident that the result of the cauliflorous condition is a marked separation of the vegetative part from the reproductive part of the plant; this is sufficiently obvious from a glance at the figures C and D, in which we are not able to see any trace of the foliage leaves. The former shows a small portion of the stem of the Judas-tree (*Cercis siliquastrum*), which is not uncommonly cultivated in Britain, and is the only example of a cauliflorous plant, that can be readily found; the latter is a tropical plant (*Sageraea cauliflora*), and presents the further peculiarity of a separation of the male and female flowers. The base of the tree in the figure is densely surrounded by the sessile, greyish-brown fruits, which attain the size of a man's fist; whilst scattered on the trunk above are the male flowers, the first branching of the stem taking place at a height of several metres above the ground. In this plant, therefore, we have three zones—the branches bearing the green, assimilating foliage leaves and absolutely devoid of flowers, the main stem with the male flowers, and the base of the stem with the female flowers.

The separation of the vegetative from the reproductive region becomes still more marked, when the flowers are only borne on special branches, developed from the main stem (Figs. A and B). Fig. A shows the lower part of the trunk of a tropical species of fig; here the flowers are mainly borne on much elongated and divided branches, arising from the base of the main stem; however, they also occur on shorter branches, developed higher up on the trunk of the tree. Fig. B is a unique case; this plant (*Cyrtandra geocarpa*) only attains a height of about a yard, and from the base of its stem a thin root-like branch, creeping horizontally along the surface of the ground and bearing at its extremity, a single, somewhat large flower, is developed. In other cases, as in the species of fig shown in the photograph, these branches are partly underground, and the flowers are frequently more or less covered by the plant-fragments, which cover the soil of a tropical forest.



Answers to Correspondents.

M.H.—THE LIFTING POWER OF A HOT AIR BALLOON. This naturally depends entirely upon the temperature to which the air is raised. It may be taken that the air would increase in volume about $\frac{1}{500}$th for each degree Fahrenheit. If the air in a 2,000 c. ft. balloon was raised one degree, it would imply that 4 c. ft. of air was discharged. Now air weighs ·08 lbs. per c. ft. Therefore for every degree the temperature is raised the balloon would lift ·32 lbs: If raised to 100° above that of the surrounding atmosphere, it would lift 32 lbs. In general practice not much more than this is counted on, but with special heating apparatus, such as that employed by Mr. Maskelyne, a far higher temperature can be imparted to the air. The temperature in the immediate neighbourhood of the stove being, of course, much hotter than that near the surface of the balloon fabric.

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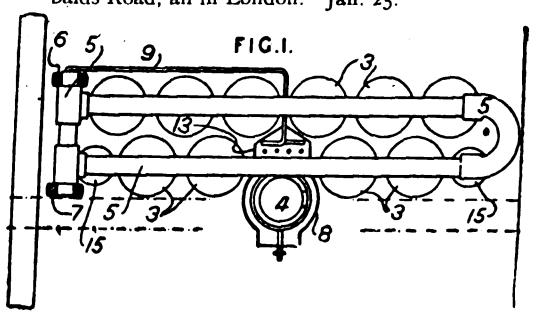
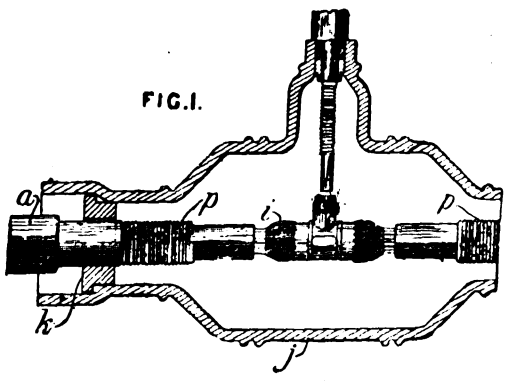
Recent Patents.

2070. Compressed-air engines. AINLEY, H. F., 5, Muston Road, Clapton, WOOD, C., 6, Craven Street, City Road, and FAIR, W. F., 83, Theobalds Road, all in London. Jan. 25.

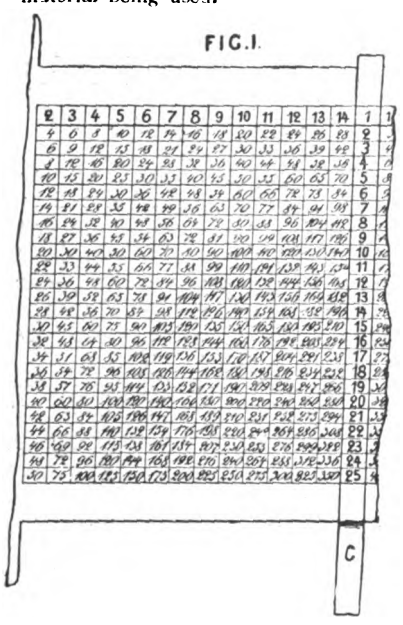


The engine is particularly applicable for driving vehicles. A large number of reservoirs 3 of highly-compressed air are connected through reducing-valves with an expansion chamber 5, which is pivoted at one end 6, 7. A copper pipe 9 leads from the axis of the trunnions to a heating-chamber 13, communicating with the cylinder jacket 8. Carbon blocks are burnt in the cylinder jacket, and warm the cylinder and pipe 9, which zigzags in the chamber 13, and is then coiled round the cylinder 4 before joining the valve chest. To stop the vehicle, pumps are put into action which charge reservoirs 15 communicating with the expansion chamber 5.

2084. Electric Joints and Boxes therefor. WILKINSON, G., Kirkside, Bilton, Harogate, Yorkshire. Jan. 27.

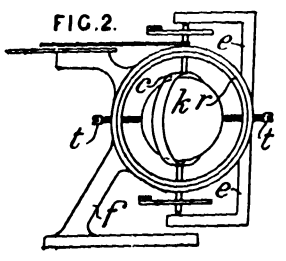


Relates to means for forming **T** and other joints and for enclosing the same. The cable is stepped to the lead sheathing *a* to form, with packing and the wood collar *k*, a good joint in the two-part box *j*. The sheathing *p* is corrugated transversely by a tool formed of a jointed ring carrying cutting or pressing wheels. In concentric cables, the outer conductor is spread over the ends of a similar inner joint box, the strands being bound with wire *i* and soldered. The inner conductors are similarly jointed, the parts of the boxes being bound together. Long openings are provided for filling, with insulating material, lids having depending flanges, to grip in the insulating material being used.



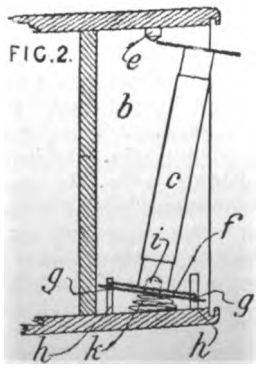
2104. Calculating Apparatus. BÖRNER, F., 66, Kaiserstrasse, Frankfort o/M, Germany. Jan. 27.

Consists of a multiplication table upon a card with or without a cursor *c*. It may be printed on a postcard, and advertisements may occupy the margin.



2125. Electricity, Measuring. FRANKE, R., 7, Geibelstrasse, Hanover, Germany. Jan. 27.

Electromagnetic meters.—A measuring instrument has a circular movable coil *c* supported in brackets *e* on a non-magnetic ring *r* and a stand *f*. The coil turns in hemispherical cavities in two pole-pieces, not shown, which are screwed into or otherwise attached to the ring *r*, and it surrounds a spherical core *k* carried by two screws *t* in the ring *r*.



2442. Photography. HOUGHTON, G., 88, High Holborn, W.C, and HOLMES, H., 3, Park Works, Park Street, Islington, N. Jan. 30.

Cameras; roller slides.—Relates to a method of inserting and removing film spools in cameras. One stud *e* is fixed to the end of the spool chamber *b* in the camera. The other stud *i* is mounted on a spring-supported platform *f* which can be tilted to one side, for inserting or removing the spool *c*, as shown in Fig. 2. The platform *f* is supported by a spring *k*, and guided by pins *g* working in slots *h*.

Prize Competition.

ONE of the principal objects of this journal being to encourage and foster the introduction and propagation of new ideas, the Proprietor offers a series of money prizes to those who, in his opinion, send in the best and most practical solutions to certain problems, which will be set each month.

The competitor gaining the greatest amount of marks each month will be awarded the monthly prize of ONE GUINEA. But in order to encourage clever inventors, and not merely reward those who may happen to hit upon a happy idea, a GRAND PRIZE OF **ONE HUNDRED POUNDS** will be awarded—after twelve problems have been sent—to that inventor who shall have gained the greatest aggregate of marks during that period, provided he shall have gained at least *30 per cent. of the full marks* in at least six of the competitions (whether he has gained a monthly prize or not).

RULES.

1. Designs to be sent in to the office before the end of the current month, accompanied by the coupon cut from this paper.
2. The solutions sent in must be concise, yet fully descriptive of the idea intended. To comply with this they must not exceed 300 words, and not more than two simple diagrams should accompany it.
3. Solutions will be published as considered desirable by the editor.
4. Competitors may obtain patent rights for their ideas, but they must run all risk of the publication in this paper interfering with the obtaining of such rights.
5. Competitors may send in their designs under a fancy name for publication, but their true names and addresses must be inserted on the coupon, which, in the event of their winning a prize, will be published. The same fancy name must be adhered to throughout in future.
6. The same person may send in two solutions so long as a separate coupon accompanies each. All marks so gained will count for the grand prize, but the monthly prize will only be awarded for the one best solution. If the two solutions appear to the judge to be but slight variations of the same invention, marks will be deducted from the second solution.
7. Novelty of design is not a *sina qua non* (since this would be extremely difficult to prove), but only the person sending a description with the coupon is entitled to reward.
8. It would add to the value if a statement be added to say if the design has been practically tried; but to corroborate this the inventor may be called upon to give a demonstration before receiving a prize.
9. In the event of an equality of marks or any other exceptional circumstances, the proprietor will decide on the fairest method of distributing the prize.
10. Non-compliance with the above rules may disqualify a competitor.

(An error was made in the summing up published last month, "Kass" having gained altogether 534 not 434 marks.)

The subject for this month will be—

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THE ILLUSTRATED

Scientific News.

A Monthly Journal devoted to Popular Science.

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Portraits of Scientific Men.

BY PROFESSOR H. H. TURNER, *Savilian Professor of Astronomy.*

IN one of the earlier numbers of this paper a plea was entered for the collection and preservation of anecdotes, or other biographical touches of a human kind, of our great scientific men. Sometimes a single story will give us a more vivid picture of a man than a whole treatise on his character and attainments, and we cannot afford to lose the acquaintance of the great men of the past, if a little care will retain it for us. The difficulty is, of course, that the really interesting and significant stories cannot be published in the life-time of the hero; or, even, for some time after his death. We cannot secure the services of a competent biographer to represent the living man by a few skilful touches of incident, as an artist can present him with line and colour; in biography we only get post-mortem pictures, which are admittedly unsatisfactory.

It is some compensation that as regards pictures in the literal sense we are not badly off. A glance at our National Portrait Gallery, or at the excellent catalogue of it, which gives such a vast amount of information for sixpence, shows that science has been treated fairly well in the matter of portraits. There are, of course, some omissions, but it must be remembered that the collection is still in its youth, and some of the blanks may yet be filled up. But one is glad to see, for instance, what Harvey was like; and when the catalogue tells us that he was "very cholerique, and in his younger days would be apt to drawe out his dagger upon every slight occasion," we feel that there was a certain fitness in his discovering the circulation of the blood. William Gilbert, who discovered magnetism, is one of the omissions; but there is Canton, who was one of the pioneers in magnetism; and there are Babbage and Boyle, and Cocker and Dalton, and many others. There is a beautiful picture of Newton, with Judge Jeffreys and Sir Christopher Wren on either side. Date, of course, is responsible for the juxtaposition, but Wren and Newton have more in common than is generally known, for Wren was an astronomer before he was an architect. Indeed, his genius was versatile to a degree, and if Newton, as a boy, made sundials (one of which the Royal Society still has), Wren invented, at the age of thirteen, "an astronomical instrument (which he dedicated to his father in Latin rhyme), a pneumatic engine, and a peculiar instrument of use in Gnomonics, which he explained in a treatise entitled, *Scistericon Catholicum*."* And later, the future architect of St. Paul's and half London, became an accomplished anatomist, and "originated the physiological experiment of injecting various liquors into the veins of living animals." They were happy days in the seventeenth century, when a man of science might know the whole of science, and, perhaps, art as well, if he happened to be a genius like Wren.

It is pleasant to know that England possesses many portraits of Newton. There is, in the National Portrait Gallery, besides the picture above-mentioned, a marble bust copied from a bust by Roubilliac. There is the statue at Trinity College, Cambridge, and one at Grantham. The Royal Society has the bust by Roubilliac, three pictures, and several engravings, and in the library is a large collection in several huge volumes, of all known prints of Newton and his contemporaries, and so on. All of them are, of course, not equally authentic, but there is one curious relic at the Royal Society of undoubted and somewhat gruesome authenticity—the original mask of Sir Isaac Newton's face, from the cast taken after death. It belonged to Roubilliac, and was used by him in sculpturing the bust above-mentioned; at his death it was sold with his effects, and passed into the possession of a dealer in statues in Tichborne Street; from whom it was purchased 50 or 60 years later for a few shillings, by the Secretary of the Royal Society, Samuel Hunter Christie, who happened to enquire about a bust of Newton. The story makes one wonder whether, after all, we have been careful enough of Newton's memory; and it is not the only incident of the kind. For instance, is it creditable to us as a nation that Newton's old house, just off Leicester Square, should be at present let in rather squalid tenements? We take better care of Carlyle's old house.

Professor S. H. Christie, who rescued the Newton mask, ought to be known, but is not, as the inventor of that everyday electrical instrument usually called "Wheatstone's Bridge." Wheatstone only brought Christie's invention into greater notice; but an undiscriminating posterity has forgotten the inventor, and immortalized the middleman. S. H. Christie was also the father of the present Astronomer-Royal; and this leads us by an easy transition to consider the portraits of the Astronomers-Royal. There have been eight altogether, Flamsteed, Halley, Bradley, Bliss, Maskelyne, Pond, Airy, Christie; and of these eight only Bradley and Maskelyne are represented at all in the National Portrait Gallery, the former by a copied picture, and the latter as one of a group of 48 scientific men. Pictures are in existence of all of the eight, except Bliss, and it is to be hoped that copies or originals will find their way into the Gallery some day. The only known authentic portrait of Bliss was scratched by a boon companion on a quart pot with the inscription, "This, sure, is Bliss, if bliss on earth there be!" which suggests that there were happy days in the eighteenth century as well as in the seventeenth. But I don't suppose this reminiscence of Bliss would be admitted in our sober twentieth century gallery. It is to be hoped, though, that they will get some picture of Halley. His comet will be back in 1910, and, perhaps, that will afford a good opportunity. He was great not only for what he did himself, but for what he made others do. We might never have had Newton's *Principia* but for Halley; and it was Halley who founded the Royal Society Club.

The collection of pictures of scientific men at the Royal Society is, naturally, a very fine one. (There are two of Halley there, by the way.) Those who do not know the fact already will hear with interest that a portrait of Lord Rayleigh is likely soon to be added to the collection. He has certainly earned his place there; indeed, it may be a surprise to many to hear that he is not there already. The fact is that men of science are generally so busy in pursuit of new knowledge, that they are apt to forget the just tribute to what has been already done. There are at least two other men still living whose portraits ought to be added to the Royal Society's collection without delay; viz., the present President and his predecessor. Sir William Huggins is the founder of the new science of Astrophysics; and Lord Lister has revolutionized surgery. These are not everyday achievements.

* Weld's History of the Royal Society, Vol. I., p. 272.

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The Collins Wireless Telephone.

WHEN the wireless telegraph became a commercial fact, the utility of a telephone without wires was at once apparent, but what was not so apparent was how a practical working instrument could be devised.

There were, prior to the invention of the wireless telephone now under consideration, several known experimental methods capable of transmitting and receiving articulate speech at a distance without metallic connection, but upon close investigation it was evident that the limitations of the conductivity, inductivity, photophonic, and other methods rendered useless further researches along these lines.

To those who have not followed the art, it is often asked why the Hertzian waves, now employed in wireless telegraphy, are not also utilized in wireless telephony. The answer is simple; there is a vast difference between the two, although both are "wireless."

In virtue of the fact that high-frequency oscillating currents such as are necessary in wireless telegraphy are not interrupted and periodic, whilst the requirements of wireless telephony demand a pure undulatory or wave form of current—the two systems are, therefore, very unlike. Mr. A. Frederick Collins' wireless telephone has just been given a commercial trial on the Hudson River, New York City, the test having been made between the ferry-boats *John G. McCollough* and the *Ridgewood*, belonging to the Erie Railroad. A modification of the Hertzian wave method is here employed, and instead of a spark leaping between two brass spheres to set into action oscillations having a frequency of a million per second, metal discs took the place of the ordinary spark gap; these were placed within one-fiftieth of an inch of each other, and acted simply as an air condenser. The potential generated by the transformer coil was high but the frequency was low, compared with that of an ordinary spark discharge, but a mechanically high frequency—as opposed to an electrically high frequency—was produced by a special device, and thus, while some of the elements of the wireless telegraph system were retained, a side wave resulted, rendering the current suitable for the transmission and propagation of articulate speech.

The apparatus is very simple, consisting essentially of an aerial wire elevated to the top of the ferry-boat's flagstaff, and a copper plate held under water at the end of a wire connecting with the telephonic transmitter and receiver in the boat's pilot house. Ordinary electric batteries complete the outfit. Each of the two boats employed for the experiments carried an outfit of this kind.

The recent tests on the boats—undertaken to demonstrate the commercial practicability of the Collins system—was the outcome of a series of experiments beginning in Philadelphia two years ago and extending throughout the preceding summer at Rockland Lake, New York State, where wireless telephone messages were transmitted a distance of a mile clearly and distinctly.

The present value of the wireless telephone, as Mr. Collins points out, lies in its immediate adoption by all types of craft in harbours, from the tug-boat to the largest steamship; in cases of fog or the darkness of night, a word of warning may be spoken from one vessel to another, and the captains or pilots by stating the position of their ships would learn exactly each other's course, and would steer accordingly.

A long-distance wireless telephone is not needed under these conditions, but one working over a comparitively short distance would serve admirably as a conditional block-signal system, averting collisions and avoiding danger. The Collins apparatus was taken up by the Erie Railroad, who have given the inventor every facility to demonstrate its worth. The inventor's address is 11, Broadway, New York City.

Dr. Frederick Collins' System of Wireless Telephony—The Receiving and Sending Instrument.

Sunspots and Rainfall.

JUNE'S heavy rainfall, inconvenient as it has been to the world at large, has, however, given satisfaction to some of the weather observers at South Kensington. In the Solar Physics Observatory is a chart drawn up by Dr. W. S. Lockyer, showing the increase or decrease of sunspot area; in connection with it, other curves show the rainfall in different areas and countries. It is attempted by means of these curves to demonstrate some relation between sunspots and rainfall, an attempt which has been so far unsuccessful; but this year these rain-curves are all going up with the approach to the thirty-five year sunspot maximum. The heavy rainfall has, at any rate, purified the air of London, probably by oxidising it, but certainly by washing down solid particles. Some rain-water that was collected in the Strand between June 13 and 15 was found to contain more than nine grains of solid matter per gallon. There were traces of salt, ammonium sulphate, organic ammonia, and nitrates; though the chief constituents were soot and similarly suspended matter. Taking the rainfall as 3.8 in. in five days, there fell over London's 73,839 acres some 6,437,230,000 gallons in five days. In this there were 3,738 tons of solid matter, 330 tons of salt, 267 tons of ammonium sulphate, and about 2,000 tons of soot.

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Scientific Knot Tying.

THE joining together of two pieces of string or rope is often a matter of some importance. The ignorant will tie them together with any kind of knot, and not be aware how greatly the results of a strain on the rope may differ. The sailor makes a study of special knots, but his chief object is usually to so connect the ends that they can be easily unfastened again without the knot "jamming." But if the pieces are joined by means of most ordinary knots it will be found that when subjected to a severe strain the rope will as a rule break at the knot, showing that this is a source of weakness. Yet this is not always the case, and Prof. Marvin, of the United States Weather Bureau, undertook a series of careful experiments to determine what may be called the relative strength of different knots. All these tests were made on new cord, which was a hard twisted cable-laid twine, measuring between ·105 and ·115 of an inch in diameter. The following table shows the results.

STRENGTHS OF CORDS UNITED BY VARIOUS KNOTS.

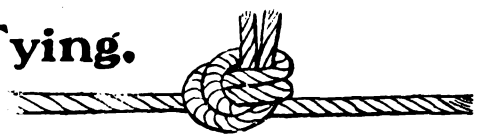
No. of Test.	Kind. 1 Double overhand knot	2 Sheet bend or weaver's knot.	3 Sheet bend, double turn	4 Square knot.	5 Fisherman's knot	6 Interlaced overhand knot.	7 Interlaced figure of 8 knot.	8 Carrick's bend.	9 Bowline bend	10 Cord Unknotted
1.	110	118	160	158	172	143	185	170	172	171
2.	138	127	110	174	173	156	138	175	187	180
3.	150	118	146	158	154	145	140	175	193	165
4.	120	125	160	110	140	174	160	161	178	167
5.	135	112	131	138	133	171	150	182	165	169
6.	....	....	....	168	....	....	140	....	191	182
7.	....	....	....	163	....	....	162	....	198	172
8.	....	....	....	143	....	....	170	....	202	160
9.	....	....	....	....	....	....	150	....	190	194
10.	....	....	....	....	....	....	135	....	185	198
Average	131	120	141	151	154	158	154	174	186	176

The illustration will show the exact structure of the knots. What is here called the "square knot" is more generally known in England as the "reef knot."

The figures in the last col. (10) are not explained, but presumably give the instances in which the cord broke in places other than where knotted.

A knot may be tied with or against the "lay" of the cord, but no difference in the strength was detected.

Altogether the double "bowline" was found to be quite the best method of fastening, as not only being the strongest, but also the easiest to untie after being strained, and the best for uniting two cords of different size.

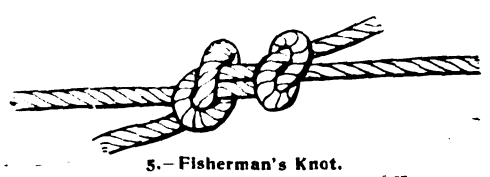


1.—Double Overhand Knot.

2.—Sheet Bend or Weaver's Knot.

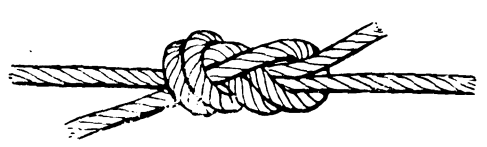
3.—Sheet Bend, Double Turn.

4.—Square Knot.

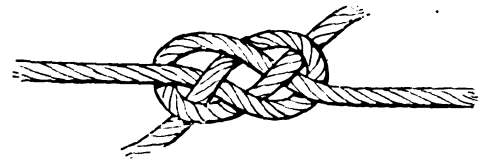


5.—Fisherman's Knot.

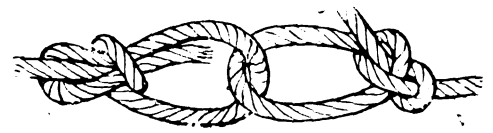
6.—Interlaced Overhand Knot.



7.—Interlaced Figure o 8 Knot



8.—Carrick's Bend.



9.—Bowline Bend.

A Strike Cartridge.

IN the United States the workman, though reputedly better off than the British workman, is less well organised in Trades Unions; and, in consequence, the conflicts between labour and capital are of a far more venomous description than is the case in this country; and, indeed, resolve themselves into something which is "war" in something more than name. More than once in recent years the military have been called out to quell strike riots, and the bloodshed which has ensued has led the Ordnance Department of the U.S. Army to construct what is now popularly called the "mob cartridge," but which the Department euphemistically terms "multi-ball cartridge, calibre 30." Its object is to disperse crowds as humanely as possible. It is less dangerous than the one in use; but it is still deadly, as the following description may show.

The cartridge is composed of a service case charged with a full charge, about 34 grains, of smokeless powder, and two round balls held in the neck of the case by a cannulure at the lower end and a crimp at the upper. The balls are made of a mixture of lead and tin in the proportion of 16 to 1, and are slightly coated with paraffin. The diameter of the ball is 0.308 inch, and the weight is 42 grains. The cartridges have sufficient accuracy for effective use at 200 yards, at which range a slight elevation is required. At one hundred yards it is necessary to fire point blank.

The Life of Seeds.

IT has frequently been stated that wheatears found in Egyptian tombs have shown powers of germination after having been buried for hundreds of years. As these statements do not rest on sufficiently recorded evidence, a series of experiments have been undertaken in the seed laboratory of the United States Department of Agriculture, with a view to definitely settling this question. For these experiments 112 different samples of seeds have been selected, representing 105 species, 84 genera, and 24 families. These include seeds of most of the common field and garden plants, as well as seeds of many of the grasses and the most noxious weeds. Of the greater number, 200 seeds were taken; in the case of the larger specimens, such as beans, peas, and corn, only 100 seeds. The samples of seeds were mixed with dry clay and packed in well-baked clay pots, and these pots were all buried last September in a heavy clay soil. They were buried at depths varying from six inches to three and a half feet. Altogether 32 complete sets have been buried, including 3,584 pots, and it is intended to take up one of each of these sets from time to time and test for germination. These tests will be made at the end of one, two, three, five, seven, ten, fifteen, twenty, twenty-five, thirty, forty, and fifty years. The experimenters are of the opinion that a great many of those buried at the depth of six inches will not have survived one year. Those buried deeper will probably last longer, because they are better protected from temperature and moisture. Professor T. T. Durel, who is directing the experiment, thinks it unlikely that any of the seeds will survive fifty years.

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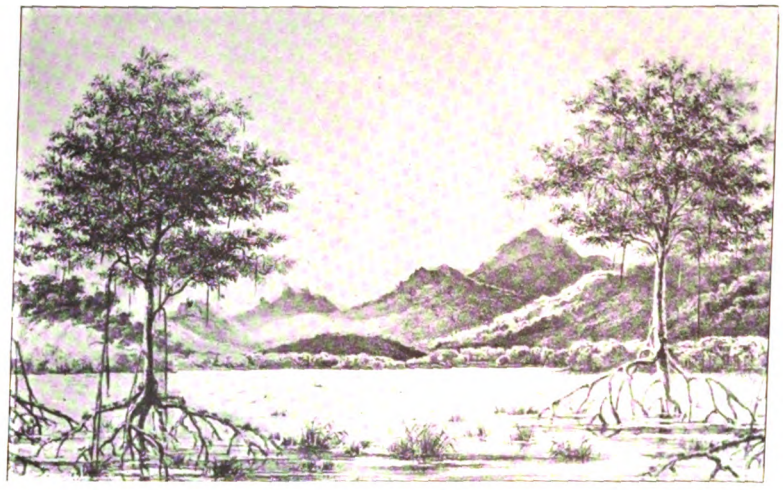
Botanical Notes.

By F. E. FRITSCH, Ph D., B.Sc.

Mangroves.

ONE of the most characteristic features of the vegetation of many of the tropical shores are the mangroves, which form such an important constituent of the so-called tidal forests. In the temperate zone the seaweeds and a small number of herbaceous flowering plants are the only customary plant-inhabitants of the shore-line, but in the quiet lagoons and bays of the tropics the forest frequently extends right down to low tide level, and not uncommonly some distance beyond it. The appearance presented by such a forest varies with the state of the tide; at high tide the mangrove-trees, which form a large part of the same, are completely immersed in the sea-water as far as their bases are concerned, and their only visible mode of attachment to the muddy



Mangrove-like Trees.

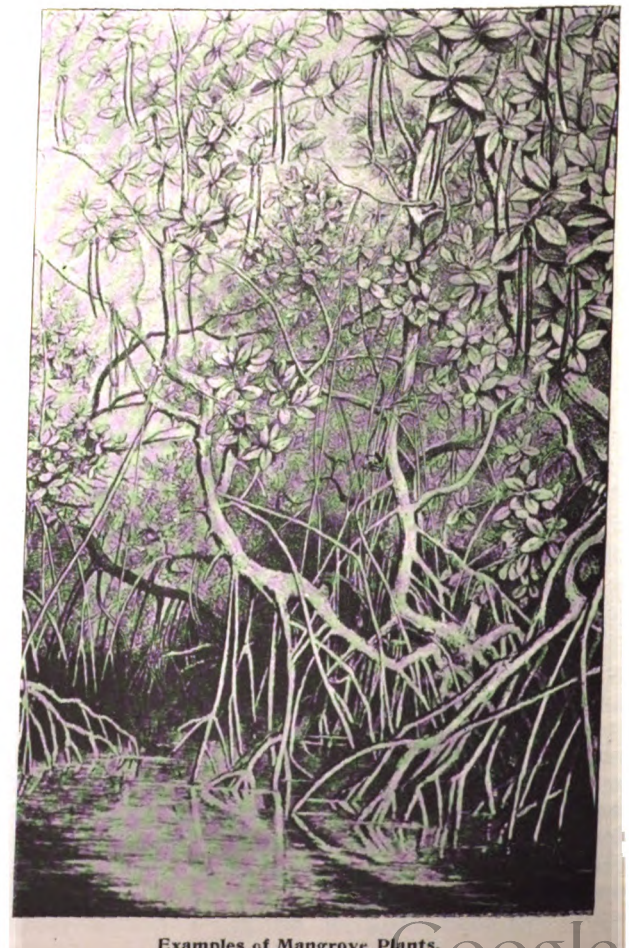
bottom below are the aerial roots, which descend from the higher portion of the trees (Fig. A on opposite page). At low tide, however, the peculiar root system is fully exposed (Fig. B); on its numerous ramifications large numbers of seaweeds are collected, and animal life is active on all sides. Owing to the accumulation of large quantities of decaying vegetable *débris*, the atmosphere of such a mangrove swamp is frequently not one of the best, but the rising tide covers in all this and leaves only the picturesque summits of the trees projecting above the water. It should be noted that certain plants invariably occur associated with the mangroves in the tidal forests, and that it is possible to distinguish sharply between the vegetation of the American mangrove-formation and that of the Indo-Malayan. Many of the associated plants exhibit features in their structure and reproduction quite like those of the mangroves I am now about to describe.

The conditions under which the mangroves grow necessitate arrangements rather different from those appertaining to ordinary land plants. In the first place the bottom of the sea, to which the roots of the mangrove are attached, is usually made up of a blackish slimy mud, which does not afford a very firm substratum; and further, the trees are in many cases subjected to the continual wash of the tides. As a consequence, we find a highly-developed root system (Figs. A and B), forming a kind of support, on which the main stem with its branched summit is borne. This support constitutes an excellent anchorage, and its effect is increased by the numerous pendant roots, formed on the higher branches, which, upon reaching the bottom, also branch to a considerable extent. This complicated, ramifying root-system, as already mentioned, encloses large quantities of decaying vegetable matter, and further, serves for the accumulation of fine sand, etc., so that on shores, inhabited by the mangrove, the coast-line is generally extending by degrees further and further into the sea. The two photographs, one of an Indo-Malayan, the other of an American species of mangrove, show the extensive root-system, forming a firm support and attachment for the stem above. The fact that mangrove-trees growing on the mainland usually develop no such complicated root-system is sufficient evidence of the latter's being an adaptation to the peculiar conditions of life. The roots, descending from the upper branches are, as a rule, unbranched until they reach the substratum; that part of them, which is usually above water, bears numerous lenticels—special apertures through which the oxygen, necessary for the respiration of the submerged roots, is taken up. Growing, as the mangroves very frequently do, in salt water, it will be understood that the conditions of nourishment also differ from those prevalent in land-plants; and this has to account for a large number of the anatomical peculiarities of the leaf.

Most interesting of all, however, is the way in which these plants reproduce, and the adaptations here found are most intimately connected with the mode of life. The fruit is about the shape of a hazel-nut, and remains attached to the parent tree until the embryo it contains is well developed. Contrary to the usual state of affairs, the fruit with its contained seed goes through no resting-stage, but the seedling commences to develop at once. The primary leaves or cotyledons remain within the body of the fruit and serve to absorb nourishment for the well-developed hypocotyl (*i.e.*, that portion of the seedling situated below the primary leaves), which grows out below. Fig. E shows the general appearance of such a seedling (much reduced); the swelling at the upper end (*f*) represents the fruit, whilst all below is hypocotyl (*h*), root-organisation only occurring in about the last millimetre (*r*); whilst Fig. C shows the fruit of another species, from which such a seedling has broken off; at its base it is still surrounded by the sepals. Large numbers of these elongated, spindle-shaped seedlings may also be seen hanging down from the branches of the trees in both photographs. By the impact of their fall the pointed lower end of the hypocotyl is forced into the mud at the bottom of the water, and in a very short space of time a number of roots are developed at this point (Fig. D), which firmly attach the young seedling to its substratum. It will readily be perceived that the spindle shape of the seedlings with the thicker end lowermost is excellently adapted for a fall in the vertical position, by which means the seedling is brought into the position necessary for further growth. Many of these seedlings become washed away again by the tide before they have obtained a proper footing; they float in the water, and will, if they reach a suitable substratum, continue their growth. In this way the mangroves are distributed from one coast to another.

Quite recently it has been shown how the growth of mangroves on the hard calcareous coral reefs on the coasts of East Africa originates. Here the sea-bottom is hard and smooth, and there is no soft mud, in which the mangrove seedlings could take root; and yet they are to be found in considerable abundance, contained in little round cavities of the limestone rock, often just big enough to enclose them. The secret of the matter is that the spindle-shaped seedlings, after falling from the parent tree, float vertically in the water with just the tip of their primary leaves projecting above the surface. With the fall of the tide it may frequently happen that the pointed lower end of the seedling is brought to rest in one of the numerous little cracks in the limestone. The ripples of the tide will then cause the seedling to oscillate about its tip and in this way it gradually bores its way into the rock and attains a firm hold.

The general features of the plants usually associated with the mangrove-trees in the tidal forests are of considerable interest, but must be reserved for a future article.



Examples of Mangrove Plants.

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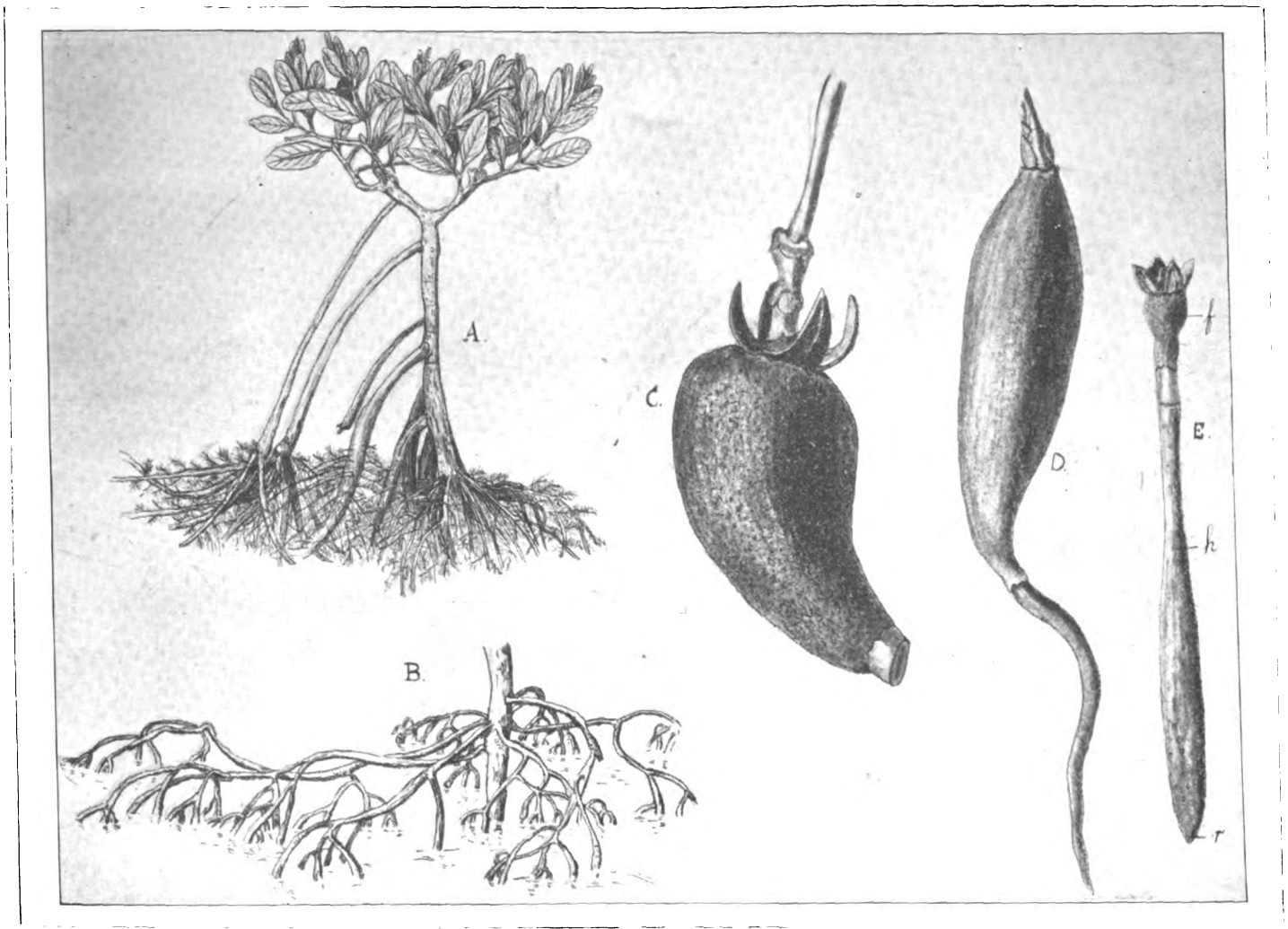
The Insect-visitors of the Primrose.

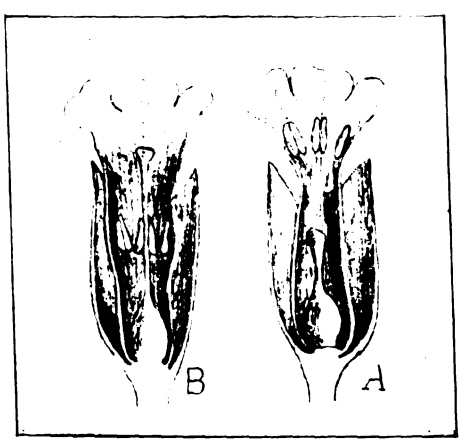
PLANTS flowering in the early portions of the year are naturally less favourably placed with regard to the chances of insect visits than is the case with the summer-flora; and for many years the question of the pollination of the primrose has been a puzzle to those who have investigated it. Darwin, owing to the scarcity of insect-visitors during the day, concludes that pollination is effected by nocturnal Lepidoptera, whilst a recent observer goes as far as to assume the entire absence of cross-pollination in the primrose. This latter view is so directly opposed to Darwin's interpretation of the characteristic floral structure of this plant, that Prof. F. E. Weiss, of Manchester, has been led to publish some observations on the insects visiting the primroses, made at a sheltered spot near Church Stretton, in Shropshire.

The most striking feature of the floral structure of the primrose has long been known, and consists, in the occurrence of flowers, with



Leaves and Roots of Mangroves.

styles and stamens of two different lengths. The one kind (long-styled flowers, Fig. B), have short stamens, which are hidden in the corolla-tube, and a long style, projecting considerably above them; whilst the other kind of flower (short-styled flowers, Fig. A) have



more or less projecting stamens and a shorter style, hidden in the tube, formed by the corolla. This phenomenon, known as *heterostyly*, is not alone confined to the primrose, occurring, for example, also in the purple loosestrife, where three different types of flowers are to be found. Darwin considered this arrangement to be an adaptation, ensuring cross-fertilisation.

To turn to Prof. Weiss's observations, which were made on eight successive days between 11 a.m. and 1 p.m. A considerable number of insects were observed. Of the long-tongued insects, *Bombylius* (Bombylüdæ) was the most frequent and constant in its visits, and seemed, moreover, to restrict themselves almost entirely to the primrose. It was observed to settle on the flower and to probe for nectar at the base of the corolla-tube; in this process the tuft of hairs on the top of its head necessarily comes into contact with the pollen of the short-styled forms, and thus the latter is conveyed to the style of the long-styled flowers in the course of subsequent visits. The larger humble-bees (*Bombus*) were also observed to occasionally visit the primrose, but were more commonly seen on other flowers (willow, dandelion, violet); smaller humble-bees (*Anthophora furcata*) were more frequent, and, in obtaining the nectar, are undoubtedly able to effect cross-pollination. Bees are rare visitors, and are unable to reach the nectar, but their occasional attempts to obtain the same may cause cross-fertilisation of the long-styled forms. Another active agent, however, is *Andrena Gwynana*, which is a regular visitor of the primrose on mild days; this insect is unable to reach the nectar, but settles on the flower in its quest after the pollen, which it gathers greedily. The pollen is only accessible to it in the short-styled forms, but its occasional futile visits to the long-styled flowers suffice to pollinate their style.

However, self-pollination is also a frequent occurrence in the primrose. Species of *Thrips* are commonly to be met with in the corolla-tube, and in these cases the latter is generally found to be covered with scattered pollen-grains along its inner surface; most probably they have been carried about there by the insects named, and in the same way pollen would also be conveyed from the stamens to the style of the same flower. Further, it seems probable that in exposed situations the wind may play an active part in the process of self-pollination. The flowers of the primrose are at first vertical in position, and in the short-styled forms the shaking, due to the wind, will cause pollen to fall from the stamens on to the stigma below; towards the end of flowering the flower droops to a greater or less extent, and in this position pollen can fall from the stamens on to the style of the long-styled forms. In the cowslip matters are just reversed, the flowers being first pendant and then erect. It thus seems that the primrose is also well suited for self-pollination, which is of importance to a plant, which flowers at a time of the year when insects are not yet abundant. However, the facts detailed above are sufficient evidence of the occurrence of cross-pollination under suitable circumstances, and this is also shown by the presence of a number of the hybrids (so-called oxlips) between the primrose and cowslip in the locality under observation.

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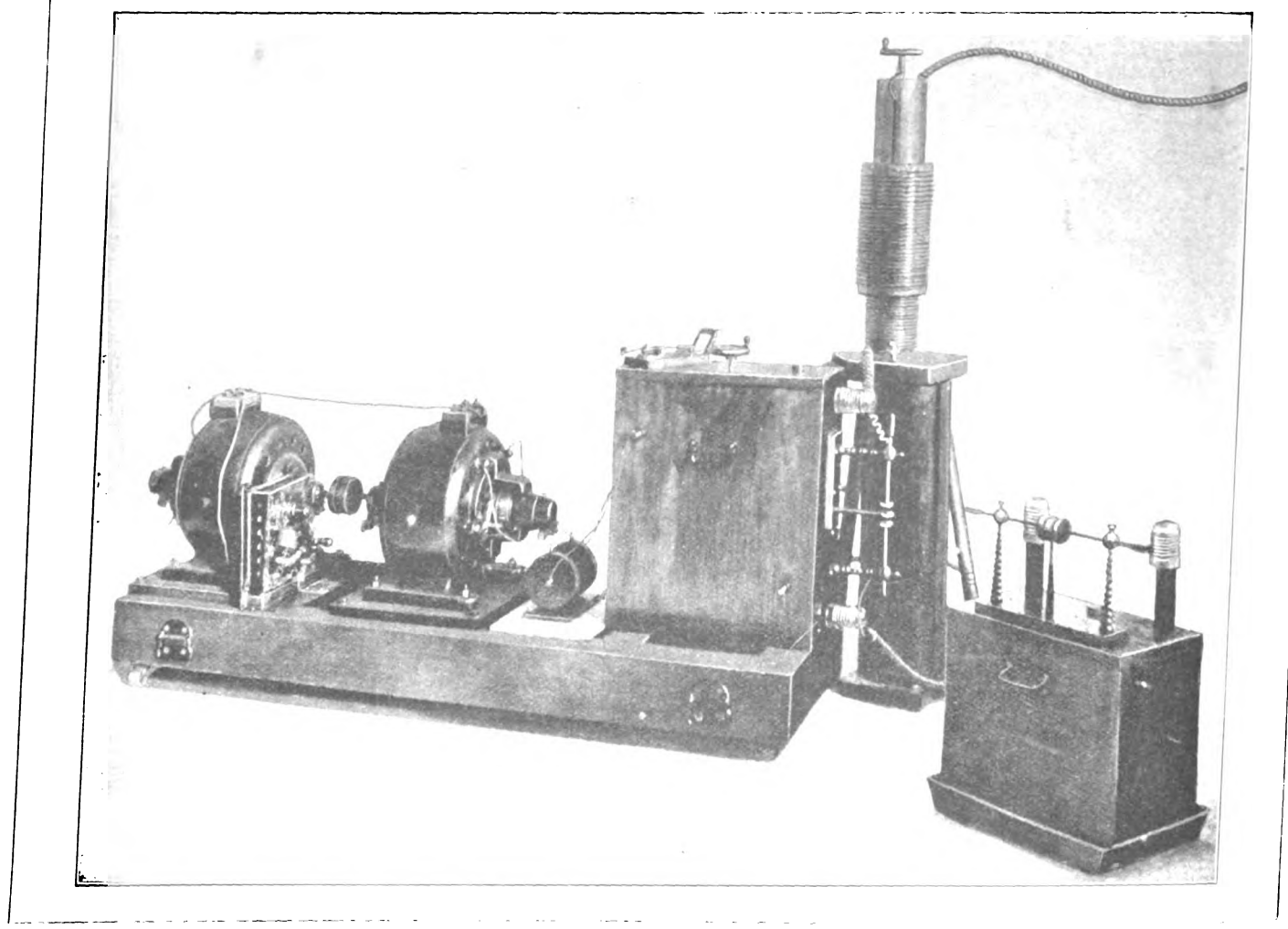
The De Forest Wireless Telegraph System.

IN the De Forest wireless telegraphy system, which shares with the Fessenden system the testimonial of continuous experiment in the United States Navy, the principal feature is the form of the receiving instrument, which will be presently described. The transmitter is of the simplest possible type. According to Professor Fleming's article on "Hertzian Wave Telegraphy" in the *Popular Science Monthly*, there are three, and at present only three, modes of exciting the electrical oscillations in the aërial wire which sends out the Hertzian waves. First the aërial may itself be used as an electrical reservoir, and charged to a high potential, and suddenly discharged to the earth. That was Marconi's first method. The second method, due to Braun, consists of attaching the aërial to some point on an oscillation circuit which consists of a denser, an inductance coil, and a spark-gap, in series with one another. The condenser is charged and discharged across the spark-gap so as to create alterations of potential at some point on the oscillation circuit. In this case the aërial wire has to be so proportioned that it is in tune—resonant to this frequency of oscillation. Thirdly, we may employ the arrangement involving an oscillation transformer, in which the oscillations in the primary condenser circuit are made to induce other oscillations in the aërial circuit, the time-period of the two circuits being the same.

But the De Forest system is a simple adaptation of the first of these systems, and an alternating current transferred to a high potential is applied direct to the spark-gap with a Leyden battery in shunt. For the following description we are indebted to our contemporary, the *Electrician*.

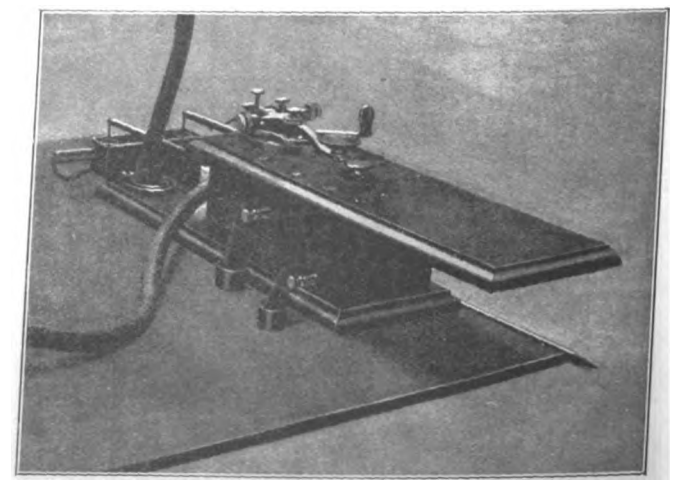
In the De Forest sending apparatus no interrupters or coils are employed, but an ordinary alternating current. The set ordinarily used consists of a motor-generator (where alternating current cannot be obtained directly from the mains) delivering at 500 volts and 60 cycles per second. A special key breaks this circuit as rapidly as any Morse operator can send a wire. A speed of 48 words per minute (commercial message without coding) has, we are informed, actually been accomplished, and this, we believe, represents the record for speed of word transmission for wireless telegraphy. The alternating current from the generator is stepped up to 25,000 volts by a special transformer, and this is applied directly to the double spark-gap and a Leyden jar battery which is shunted to the gap. The capacity of this condenser is adjusted to suit the output of the generator used; with a 1 kw. generator 6 or 8-quart Leyden jars are used in parallel. The terminals of the spark-gap are disc or mushroom-shaped instead of being spherical, and each of the two gaps is about $\frac{1}{4}$-in. long. This arrangement, placed vertically, as seen in the illustration, is said to give a spark of exceptional clearness and power.

The more distinctive feature of the system is the instrument devised for receiving the waves. It depends on an electrolytic principle for its action. Between two electrodes of soft metal is placed a soft paste containing some electrolisable fluid, metallic particles, and some viscous material. Under the action of the local battery, minute conducting particles are torn off from the electrodes and made to bridge the gap. The resistance of the device is, therefore, ordinarily small, but under the action of the electric waves electrolysis is suddenly set up and minute hydrogen bubbles are generated at the cathode. This suddenly disrupts the conducting chains and greatly increases the resistance of the responder. The oxygen seems to combine with the anodic metal, and the hydrogen quickly combines with a depolarising agent mixed with the paste. The action is thus instant and automatic, and allows the use of a telephone for receiving instrument.



The De Forest System of Wireless Telegraphy.—A Sending Set.
(Lent by the "Electrician.")

As a gauge of the sensitiveness of the responder, it is stated that it will respond to a $\frac{1}{64}$ in. spark 45 ft. distant with antennæ only 2 ft. in height. The material in the gap should be renewed about once every



De Forest System of Wireless Telegraphy.—A Transmitting Key.
(Lent by the "Electrician.")

third day, although in certain instances it has been in successful use for weeks without renewal.

Our illustrations have been lent to us by the proprietors of the *Electrician*.

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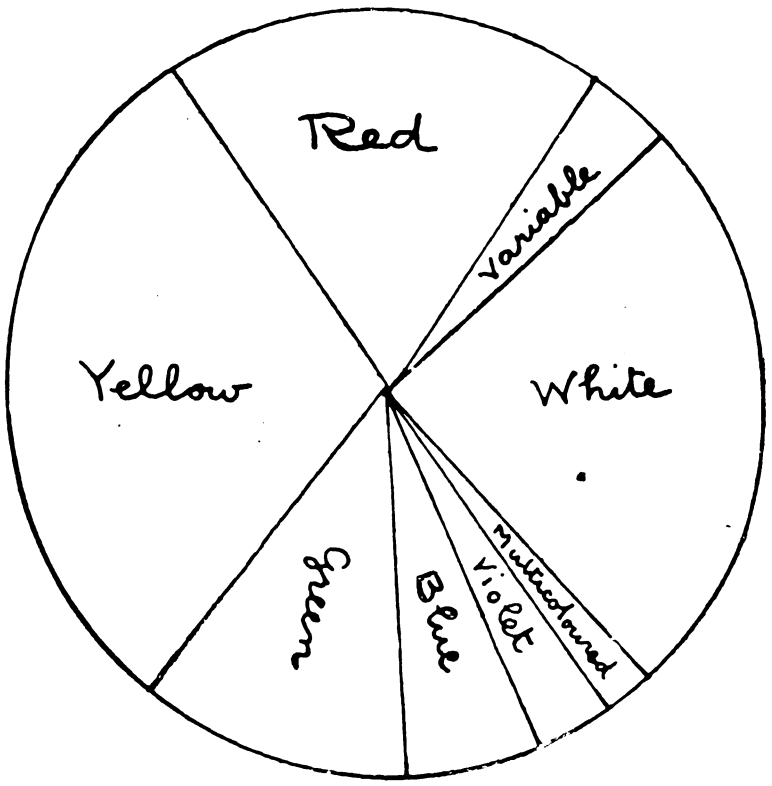
The Colours of Flowers.

M. HENRI COUPIN has just concluded an inquiry into the frequency of the colours that occur in flowers in France. The colours are subdivided into hues that will be easily recognisable in the following table. Opposite each colour is the number of times that it occurs.

Bleu	.. .. ..	116	
Bleuâtre	.. ..	29	
Bleu, pâle	.. ..	12	
Blanc	.. .. ..	480	
Blanchâtre	.. ..	70	
Blanc, rose	.. ..	29	
Blanc, rougeâtre	..	4	
Blanc, jaunâtre	..	43	
Blanc, verdâtre	..	56	
Rouge	.. .. ..	69	
Rose ou Rosé	.. ..	289	
Purpurine	.. ..	6	
Rouge, vineux	.. ..	4	
Rouge, claire	.. ..	2	
Rougeâtre	.. ..	29	
Pourpre	.. .. ..	40	
Rouge, brun	.. ..	16	
Rose, pourpré	.. ..	23	
Rose, violet ou lilacé	..	27	
Vert	.. .. .	16	
Verdâtre	.. ..	297	
Jaune	.. .. ..	600	
Jaune, claire	.. ..	39	
Jaunâtre ou brun jaunâtre	.. .. ..	106	
Jaune, soufre	.. ..	2	
Jaune, orangé ou rosé	..	21	
Jaune, verdâtre	..	46	
Violet	.. .. ..	59	
Violace	.. .. ..	29	
Lilas	.. .. ..	29	
Violet, pourpre	..	5	
Variable	.. ..	136	
Multicoloré	.. ..	68	



Diagram, showing by the size of the sectors of a circle, the distribution of flower colours in France.

These hues may be summed up under more generic and definite tints; and when these are assembled in order of precedence, yellow is found to be the colour with the largest number of representatives—808. White comes next with 687, red next with 505, and green 313, blue 157, variable colours 136, violet 122, and multi-coloured 68, in the order and with the number of representatives named. The accompanying diagram, a circle with colour divisions indicated, shows roughly the comparative frequency of the various colours. The colours of the flowers vary largely with their surroundings. Thus the yellows occur most frequently in mountainous districts, the white flowers in the fields and woods, the green flowers by the borders of lakes and on the sea coast.

Geological Discoveries in Denmark.

SOME interesting information as to the formation of the soil of Denmark has recently appeared. For a number of years borings had been carried out, since 1893, near Copenhagen, originally to reach water, but this soon failing, the work was continued for purely scientific purposes. Owing to the thickness of the chalk and the masses of flint that the Danish soil consists of, the work was made very difficult, and only slow progress was made. Only a total depth of 1,920 feet has as yet been reached; layers of a marl formation were noticed at 1,800 feet below surface, consisting of alternately thin layers of grey slatish clay and soft, white chalk stone. These series of layers found are not known to exist in the other countries of the Baltic, but correspond with those found in England, so that important conclusions as to the seas of an earlier age and the movements of the crust of the earth may be arrived at. The heat at the lowest depth reached was measured to be a little over 21 degrees of Celsius.

Wireless Telegraphy
Between Poldhu and the Royal Institution.

BEING desirous that the audience at a lecture delivered at the Royal Institution on June 4th last on Wireless Telegraphy should be able to see the actual receipt of wireless messages over long distances a mast was erected by Professor Fleming on the roof of the Royal Institution just above the Lecture Theatre. This was erected and stayed near to the dome, which covers the roof, and from it a stranded copper wire carried on an insulator suspended so as to come down through an opening in the roof into the theatre. The next difficulty was to obtain a good earth. This, however, was done by sinking a large zinc plate in the ground in a cellar and leading a wide strip of zinc connected to it up into the building. Having made these arrangements it was found that very good signals and messages could be received from University College, Gower Street, where a small apparatus for creating Hertzian waves and radiating them from an aërial wire had also been arranged.

This experiment was very interesting as the aërial wire at University College was lower than the surrounding buildings. These electric waves were, therefore, coming across London through much more than a mile of thickness of houses, each consisting of a mass of brick and stone, iron girders, and a perfect forest of iron and lead water pipes, gas pipes, heating pipes, and an entanglement of electric wires. Through all this obstruction, however, the electric waves made their way. But a more remarkable feat was shown. There is a Wireless Telegraph Station at Chelmsford, which is in communication with Poldhu. It was found possible to receive at the lecture table of the Royal Institution good signals on the Marconi apparatus from Chelmsford, and accordingly Mr. Marconi arranged a programme of experiments as follows:—He himself at Poldhu transmitted wireless messages, which were received and printed down on the Morse tape at Chelmsford. The operator there then repeated these, and they were received and printed down at the Royal Institution. They thus came by wireless telegraphy "all the way," 300 miles overland, and passed over or near Plymouth, Exeter, Salisbury, Basingstoke, Windsor, Reading, and all across the north of London. This experiment was repeated constantly, and shown at the lecture.

The signals received from Chelmsford (25 miles away) were wonderfully sharp and strong, and the experiment is especially interesting in showing that with proper arrangements Hertzian Wave Wireless Telegraphy can be conducted right into the heart of a large city. In the course of the morning before the lecture on June 4th, the President of the Royal Society inspected some of the tapes, which had come through with messages on them, and Professor Dewar then dispatched about 3 p.m. by ordinary wire telegraph to Mr. Marconi the following message:—

"To Mr. Marconi, Poldhu Hotel, Mullion, Cornwall.

"President of the Royal Society has seen your messages received at the Royal Institution from Poldhu by wireless, and congratulates you. The audience at Professor Fleming's lecture to-day would be interested to know when you expect to re-establish Trans-Atlantic wireless telegraphy. Reply by wireless to Royal Institution at time arranged. From Prof. Dewar, Royal Institution, Albermarle Street, London."

The reason the message was dispatched by wire was because transmitting arrangements were not available at the Royal Institution to send to Chelmsford. In the course of the lecture a reply came back from Mr. Marconi. It went direct from Poldhu, in Cornwall, to Chelmsford, by wireless, and was repeated there and retransmitted to the Royal Institution by wireless, thus coming as a wireless message all across England and into the centre of London. The following was Mr. Marconi's reply to Professor Dewar's message:—

"My best thanks to President, Royal Society, and yourself, for kind message. Communication from Canada was re-established May 3rd. Marconi."

Some messages sent from University College were read out as received, and created some amusement. One was as follows:—

"Professor Fleming. Hope you are getting this O.K. (all correct) at the Royal Institution. We are all O.K. at this end."

These demonstrations show that it is possible to receive, and, doubtless, also to transmit wireless messages from the centre of large towns and to distances, which, even apart from available bright sunshine, cannot be reached by the heliograph. Hence, in war, in the case of beseiged towns, it might make all the difference, whether the beseiged had or had not this facility. In 1870, in the Franco-German war, the beseiged residents in Paris were put to great straits to communicate with the outer world. If the Legations when shut up in Pekin had been able to receive a wireless message from the Allied Forces, their terrible anxieties might have been a little mitigated.

The result of this demonstration at the Royal Institution shows that it is now possible to communicate from Nova Scotia right into a building in London properly equipped, with one or two repetitions of the message. Wireless Telegraphy may, therefore, one day be effected directly between a room in New York and a room in the City of London without other connection than through the ether. We are only at the beginning of our knowledge as to the powers and possibilities of this new telegraphy.

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Electric Resonance and Stationary Electric Waves.

BY DR. J. A. FLEMING, F.R.S.

THE term electric resonance is employed to describe a number of electrical effects which are analogous to well-known acoustical actions. In order that a body may be capable of mechanical vibration it is an essential condition that two qualities should be present, viz., mass or inertia, and elasticity or resilience. In other words, the body must resist being displaced from a given position, and if displaced and left to itself it must return to it. In addition, there must be an inertia quality which causes the body, when returning, to overshoot the mark and hence persist in motion. Accordingly, the body must *resist* and *persist*. Illustrations of a simple kind are found in the case of a spiral spring attached at one end to a fixed support and carrying a weight at the other end. If we give the weight a movement up or down, and leave it to itself, it will continue to vibrate. In the same way, if a stiff piece of steel is fixed at one end in a vice and then pulled for a moment at the other end and released, it is set in rapid vibration. In all these cases the oscillations, if not too extensive, are isochronous, that is, the time of a single vibration is independent of the amplitude or extent of motion. This periodic time is related to the mass and elasticity in the following manner. The period or time of an oscillation varies as the square root of the mass of the vibrating body, and also as the square root of the extensibility of the spring, or its deformation per unit of force.

Suppose, for instance, that we suspend from identical spiral springs various weights in the ratio of 1, 4, 9, like letters of different weights on spring letter balances. If, then, we give these a small displacement and let them bob up and down, the times of vibration will be found to be in the ratio 1, 2, and 3. Again, if we suspend equal weights by springs having varying extensibilities, say in the ratio of 1, 4, and 9, we shall find that the times of vibration are in the ratio of 1, 2, and 3.

It can be shown, that if M represents the mass of the vibrating body, and E the extensibility or deformability of the spring as measured by the deflection produced by unit force, then

$$T = 2\pi\sqrt{M E},$$

where T is the time of a complete vibration.

Another fact to be noticed is, that in order to accumulate any considerable oscillation in such an arrangement by the application of very small blows or repeated forces, the time-interval between these impulses must agree exactly with the natural time-period of vibration of the body to be set in vibration. Thus, if we clamp one end of a steel or glass strip in a vice so that it extends horizontally, we can set it in vibration by very small blows, such as those of drops of water falling on the end, provided these come exactly at intervals agreeing with the natural or free time of vibration of the strip. It may also be shown elegantly by an experiment due to the late Prof. H. A. Rowland, of America. An ordinary pendulum has a pin attached to its bar just below the point of support. This pin may be four or five inches long, and must stick out horizontally. When the pendulum vibrates, this pin makes small excursions to and fro. If we hang on this pin a number of simple pendulums made by attaching bullets to threads, these last being of various lengths, we shall find that when the master pendulum vibrates, some of the simple pendulums are set swinging and some are not. Those are set swinging which have a natural time-period equal to, or some exact fraction of, that of the principal. In the other cases the impulses given are out of time with the natural time-period of the simple pendulum, and hence no vibration results. In these cases we have illustrations of what may be called mechanical resonance. There are other familiar effects of the same kind in acoustics. A tuning-fork struck and held in the hand gives very little audible sound at a distance, but if held over a tall glass jar or wide metal tube of the right length, closed at the bottom, the vibration of the fork sets the column of air in the tube in sympathetic vibration, and the result is a considerable increase in the loudness of the sound. The full reason of this is not easy to explain briefly. The prongs of the fork, although in vibration, have very little grip on the air, and thus only create feeble sound waves. These feeble waves can, however, excite stronger vibrations in a column of air of the right length; and this effect is called acoustic resonance.

It has long been known that there is an exactly similar effect in connection with electrical oscillations to which the term electrical resonance is applied. Without discussing this in full detail we may point out that in any electrical circuit, the quality called its inductance is analogous to mass in mechanics, whilst a capacity such as that of a Leyden jar is analogous to the elastic extensibility of a spring. Hence, if we connect together in series an inductance coil consisting of a spiral of wire and a condenser such as a Leyden jar, we have an electric circuit having a particular time-period of electrical oscillation. If we disturb the electrical charge in it by charging and then discharging it, the charge vibrates to and fro in a time T dependent upon the capacity C and the inductance L. The electrical time-period of oscillation is expressed by a mathematical equation of the same form as in the case of mechanical vibrations, viz.,

$$T = 2\pi\sqrt{L C}.$$

Supposing, then, that we have a long spiral of insulated wire and set it upright in a room, it virtually forms the inner coating of a Leyden jar, of which the walls of the room are the outer coating. It has, therefore, a certain capacity. Also in virtue of being in a spiral form it has a certain inductance. Such an insulated spiral wire has, therefore, a natural electrical time-period of vibration, and it resembles, in this respect, a column of air in a closed organ-pipe or tall jar. If we apply to one end a properly-timed series of electrical impulses or electromotive forces, the electric charge in the spiral will be set in vibration like the air in a closed organ-pipe. As in the latter case, the vibrations can be those of the fundamental or of a higher harmonic. A very convenient apparatus for exhibiting these electrical resonance effects in spiral conductors has been devised by Dr. Georg Seibt, of Berlin, and is made by the well-known instrument maker, F. Ernecke.

The general appearance is shown in Fig. 1. It consists of two large Leyden jars C1 and C2, which can be connected either in parallel or series (cascade). Also it comprises a pair of adjustable inductance

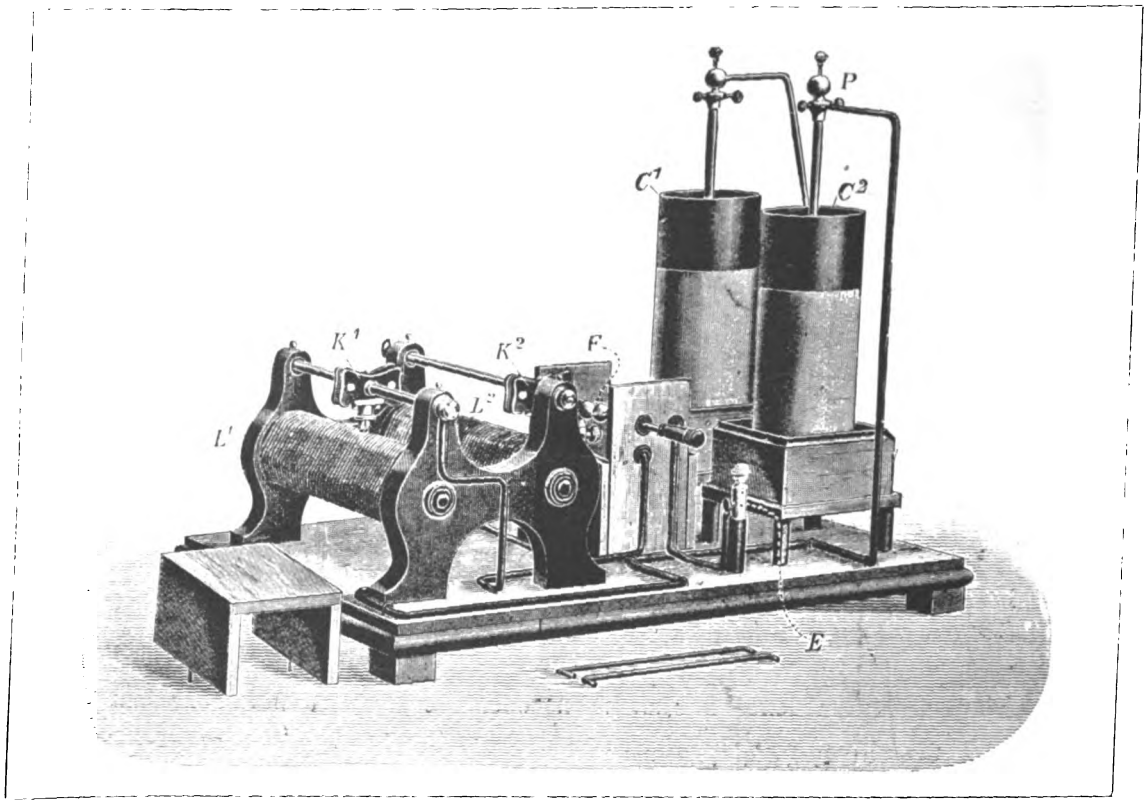

Fig. 1.—Seibt-Ernecke Apparatus for showing Phenomena of Electric Resonance.

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coils, L1 and L2, and a spark-discharger, F, in a wooden box. The user must provide a large induction coil, preferably a 10-inch coil, and the secondary terminals of this are connected to the coatings of the two jars, the arrangement of the circuit being as in Fig. 2. When

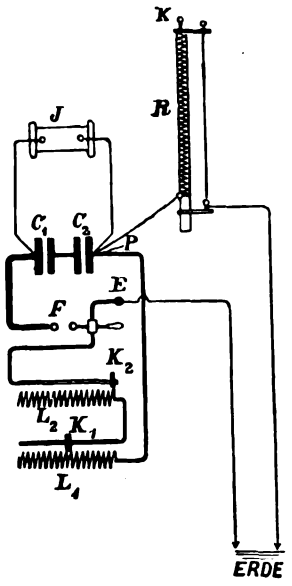

Fig. 2.

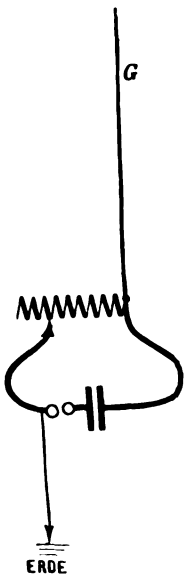

Fig. 3.

the coil is set in operation the jars are charged and discharged across the spark gap through the inductance coils.

At each discharge the charge of the jars oscillates and sets up variations of electrical potential or pressure. Hence, if we attach to one end of the inductance coil a long wire, G (see Fig. 3), the base of this wire is submitted to very rapid alternations of electric pressure, and electrical oscillations are set up in it if its inductance and capacity are such as to make it resonate with the vibrations in the jar circuit. For several reasons it is better to have the wire, G, coiled in a spiral round a wooden rod. In Seibt's apparatus a very long, fine, silk-covered wire is in this manner coiled in a spiral of one layer on a wooden rod. This spiral has its lower end connected with one point on the discharge circuit of the jars, and parallel to it is stretched a fine bare straight wire which is connected to the earth (see Fig. 2). If, then, the coil is set in operation and the inductances L1 and L2 suitably adjusted, we can make the time-period of the electrical oscillations in the jar circuit agree with the natural time-period of oscillation of the long spiral wire, R. When this is the case, we can see in a dark room a very beautiful effect, viz., an electric glow discharge between the coiled wire, R, and the straight parallel earthed wire. This glow increases in intensity all the way up the spiral wire (see Fig. 4) from the bottom, where it is absent, to the top, where it causes a brilliant electric brush at the terminal. This is the electrical expression of the fact that the amplitude of potential variation in the wire follows the same law as the amplitude of air-pressure variation in a closed organ-pipe. In fact, the spiral wire is an *electric organ-pipe* in which electric current in the wire takes the place of air motion, and electric potential the place of air pressure. Hence, the length of the spiral is one-quarter the length of the wave of the electrical oscillation excited in the jar circuit. The most interesting point, however, is that we can create in the spiral stationary waves of electric potential exactly corresponding to the overtones of a closed organ-pipe. It is well known that by overblowing a closed organ-pipe we can not only create the fundamental tones, but the harmonics which have frequencies of 3, 5, 7, etc., times the frequency of the fundamental tone. Similarly, by increasing the frequency of the electric oscillations in the jar circuit, which we can do by properly reducing the capacity and inductance, we can produce vibrations of potential respectively 3, 5, 7, etc., times as great. When this is done the electric spiral gives its electric overtones. The glow discharge between the coil and the earth wire redistributes itself indicating nodes of potential where it is absent, and loops or antinodes where it is brightest (see Fig. 5). This is a very brilliant experiment, and can be seen in a dark room by many people. Again, by earthing the top of the spiral we can make the distribution of electric potential obey the same law as that of the pressure variation in an open organ-pipe. Thus Fig. 6 shows the electric spiral acting as an open organ-pipe sounding its fundamental note. Lastly, by using spirals of different sizes, we can show the exactness of "tuning" required to set up the electrical oscillation in any one spiral, and that the frequency of potential which excites one spiral brilliantly hardly causes a slightly longer or shorter spiral to glow at all (see Fig. 7). The diagrams illustrating this article are taken from the catalogue of the well-known instrument-maker, F. Ernecke, of Berlin, who is the maker of this Seibt apparatus.

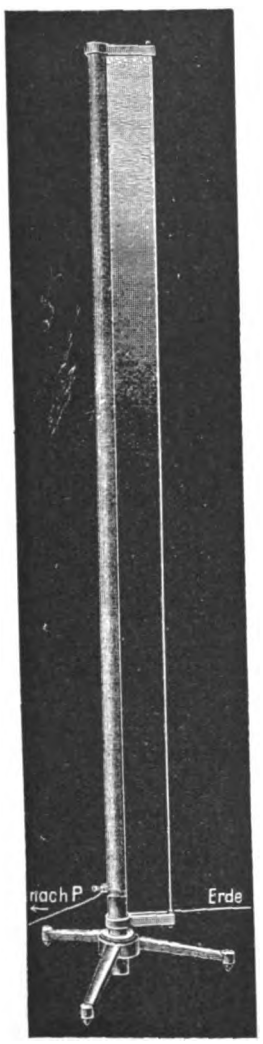

Fig. 4.

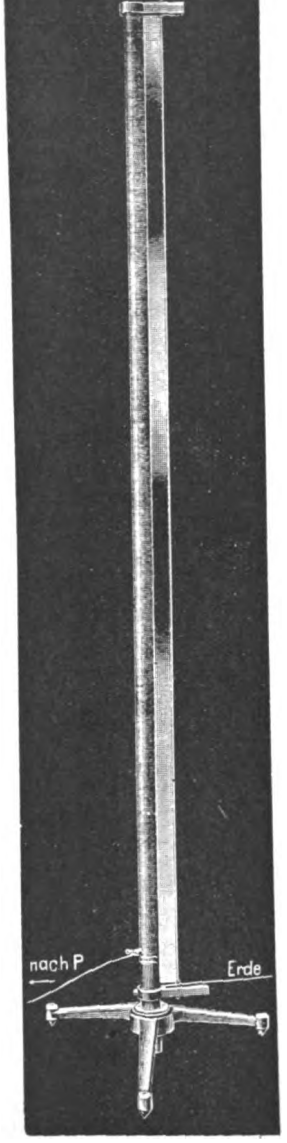

Fig. 5.—Stationary Electric Waves on a Spiral Conductor.

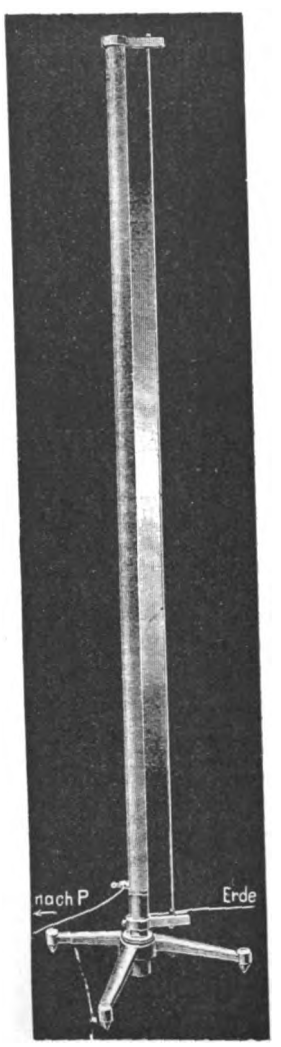

Fig. 6.

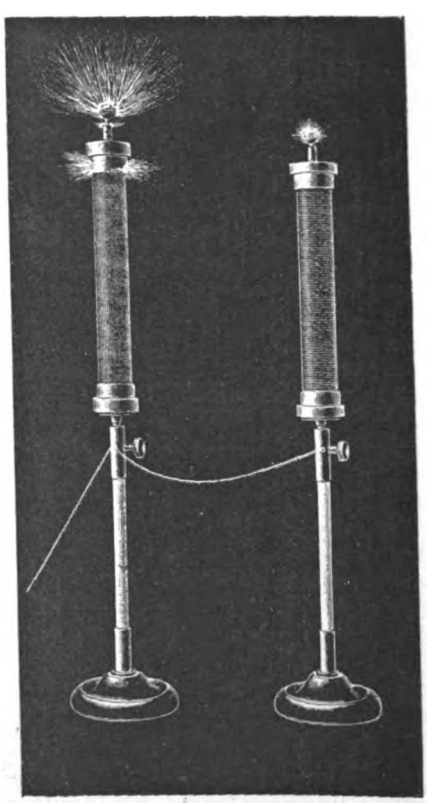

Fig. 7.

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Theories of Radium.

BY E. S. GREW.

PROFESSOR CURIE'S recent discourse at the Royal Institution was, in effect, a summary of the observed facts concerning Radium, and except in that it defined the nature of some of the properties of the metal, by showing what they were, it was rather as an assemblage of facts than a declaration of theories that the lecture was to be considered. There are three facts concerning Radium which are at present calling for particular attention, and which, moreover, are calling for a re-adjustment of existing theories of matter. The first is the fact that Radium maintains itself at a temperature higher than its surroundings. The second is that it is the centre of three distinct types of radiation which are spontaneously emitted from it. These rays, of which some account was given in the June number of the *Illustrated Scientific News*, have been defined as electrical effects, because their presence is tested and measured electrically. They are (i) the α rays, which are positively charged atoms, about the size of a hydrogen atom, and they are to be regarded as projected bodies, not as waves; the (ii) β rays are similar in all respects to the cathode rays of a Crookes tube, and are the same thing as Sir William Crookes' "radiant matter" or Dr. Johnstone Stoney's "electrons"; and (iii) the γ rays, of great penetrative power, and regarded by Sir William Crookes as ether vibrations, similar to, if not identical with, Rontgen rays. The third fact is the gaseous emanation.

Some of Professor Curie's experiments dealt with the α, β, and γ rays, and may be briefly described. A negatively-charged gold-leaf electroscope (Fig. 1) was brought near a fragment of Radium chloride. The gold leaves instantly came together, showing that the electroscope had been surrounded by an atmosphere capable of discharging it. This atmosphere may be said to have been created by the α rays—the flight of positively-charged particles—which are capable of imparting conductivity to a gas. In the second of M. Curie's experiments the fragment of Radium chloride was surrounded by a strong

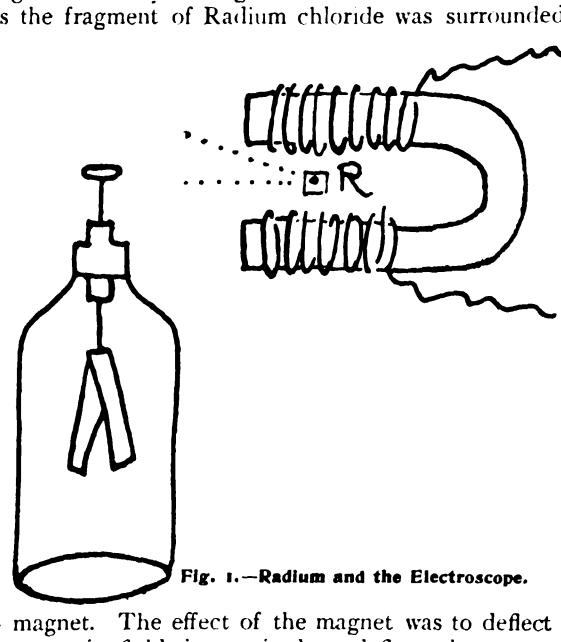

Fig. 1.—Radium and the Electroscope.

electro magnet. The effect of the magnet was to deflect the rays—a strong magnetic field is required to deflect the α rays—and the negatively-charged electroscope now remained charged.

The α rays have no great penetrative power. They are material particles, travelling at a speed of about one-tenth that of light, and are stopped, or absorbed, by thin layers of matter. A thickness of aluminium no greater than 0.0005 centimetres is sufficient to reduce their velocity to one-half. But the β rays are much more penetrative. They will pass through thicker bodies than those which are opaque to the cathode rays of a Crookes tube. The γ rays, although they are unlike the α and β rays in that they are not deviable by a magnetic field, are yet like the β rays in their penetrative power. A thickness of eight centimetres of aluminium is necessary to reduce them to half their value. However, the γ rays are to be regarded as mere satellites, attendants, of the β rays. The ability of the β rays to penetrate thicknesses of metal and produce electrical effects beyond

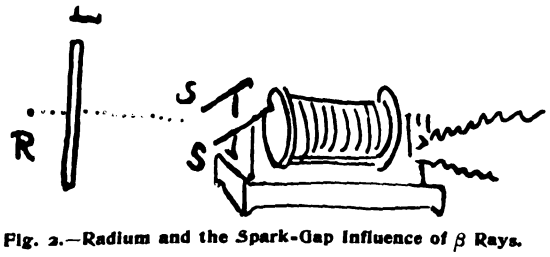

Fig. 2.—Radium and the Spark-Gap Influence of β Rays.

was shown by interposing a piece of lead of a thickness of two centimetres between the Radium chloride and the spark-gap of an induction coil. The β rays from the Radium were shown to be able to influence the spark, the interposed lead plate notwithstanding.

Apart from these rays, Radium (together with thorium, another radio-active element) gives out an emanation which, in all respects, is like a gas. Professor Curie's experiments in demonstration of this fact were extremely interesting. A glass flask (Fig. 3) containing a

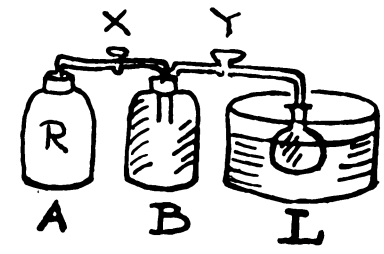

Fig. 3.—The Radium Gas Emanation.

fragment of Radium chloride was attached to a second flask, empty, by a length of glass tubing in which was a stop-cock. The second glass jar was painted with zinc sulphide, a substance which, when exposed to the influence of Radium, becomes luminous. The cock was turned, and in the darkened theatre, the glow which the zinc sulphide immediately gave out became apparent, showing that something of the nature of a gas had rushed from one flask to another. The presence of the gas was made more vivid by a continuation of the same experiment. A third vessel was attached to the zinc sulphide flask and was immersed in a Dewar flask of liquid air. (It is necessary to remark that our drawings are merely rough sketches illustrative of the methods of the experiments.) The effect of the liquid air bath when a second stop-cock in the tube connecting the second and third vessels was turned was to condense the atmosphere in both vessels to a point below the temperature at which it could remain gaseous. The illumination in the zinc sulphide flask immediately disappeared, showing that the cause producing it had disappeared, and that this cause, therefore, was probably a gas which had been condensed by the cold.

At the Royal Society on the same night as that of Professor Curie's lecture, Professor Rutherford exhibited an apparatus which is designed to show the nature of this gas. Professor Rutherford's experiments have, however, hitherto been made with Thorium, another substance which is radio-active, though much less conspicuously so than Radium, and which resembles Radium in emitting a gas. In Professor Rutherford's apparatus a slow stream of air from an ordinary aspirator is passed through a tube containing Thorium oxide, and then along a length of several yards of tubing to an electroscope. The electroscope, as in Professor Curie's experiment already described, is discharged. A coil of lead tubing is now immersed in a Dewar vacuum jacketed vessel of liquid air, and is connected to the stream tube. The escaping air (at a temperature of 120 degrees to 150 degrees below Zero Centigrade) is now unable to discharge the gold leaves. With Radium, the condensation occurs at 150 degrees below Zero. Further examination of this Radium emanation which has been conducted by Professor Curie leaves no doubt that it behaves in all respects like a real gas, and its coefficient of diffusion has been measured. It has a probable molecular weight of about 100, and it (or they, if we are speaking of the emanations) seems to be entirely inert in respect of chemical action. Its most extraordinary characteristic is that, like Radium itself, the emanation is able to excite activity in other bodies.*

This property of exciting radiation in other bodies has for a long time been known to be characteristic of certain radio-active substances. It was found in Uranium by Sir William Crookes; and Professors Rutherford and Soddy have examined the "excited activity" of Thorium with great minuteness. Sir William Crookes showed by a chemical process that the "something" that was sending out rays from Uranium, "the radio-active property ascribed to Uranium and its compounds, is not an inherent property of the element, but resides in some outside body, which can be separated from it." This radio-active constituent was called "Uranium X" or "Ur X," and was supposed to be possibly identical with Radium—though now its identity is open to considerable doubt. Similarly Professor Rutherford and Mr. Soddy have found that the radio-active constituent "Thorium X" can be separated from Thorium. Perhaps some means may be found of isolating a "Radium X." But here comes the anomaly. Both "Uranium X" and "Thorium X" lose their radiant activity after a time. The Uranium and the Thorium, which have been robbed of it by chemical means, regain it by some unknown process. In the case of Uranium, Sir William Crookes observed that the separated activity had completely decayed after the lapse of a year, by which time the Uranium itself had completely recovered its activity. Similarly with Thorium and Thorium X. The Thorium X, at first intensely active, becomes less so with time. After four days it is but half as active as at first, after eight days only a quarter, and so on. But the precipitated Thorium from which it has been separated gradually recovers the activity which it has lost. At the end of three weeks no rays can be detected in what once was Thorium X, while the Thorium possesses its full amount, and the process apparently stops. But if subjected to the same treatment as before, a new amount of Thorium X

* It may perhaps be of interest to mention that Professor Godspeed, of Pennsylvania University, has lately written an account of some experiments which have satisfied him that X rays excite a force of radiant activity on bodies with which they come into contact; and that bodies subject to X ray influence do themselves emit a secondary radiation.

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can now be got from the Thorium, just as active as the first amount, and the process can be repeated indefinitely.

According to Professor Rutherford's theory, what is happening is this: Thorium—and Radium, as also Uranium—are undergoing slow spontaneous change into other substances, which, for a short time after their birth, so to speak, possess the power of emitting rays. It is the continuous nature of the change which gives to radio-activity its permanence. The rays themselves are always dying down, but are always being renewed. We might indicate the processes by Professor Rutherford's genealogical table.

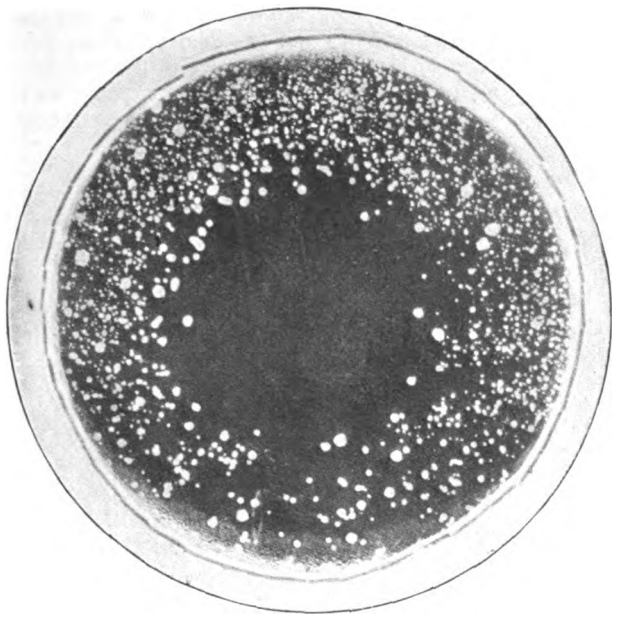

Fig. 4.—B. coli communis on gelatin, exposed to radium for twenty-four hours.

Thorium
∨
Thorium X
∨
Emanation
∨
Excited activity
∨
?

In Radium we may suppose the same processes to be going on. Substances such as Zinc Sulphide or Platinocyanide of Barium, when exposed to the influence of a Radium salt, become vividly radio-active; and all substances, even the human eye, become to some extent radio-active. That is because clinging to them is some imperceptibly small quantity of the radio-active substance, the emanation. There is, however, one fact to be noted. In Radium, as also in Thorium and Uranium, part of the radio-activity is non-separable from the original radio-active substance; and this part we may suppose to be the α rays, the positively charged atoms that fly off. The secondary radio-activity produced by the emanation has none of these rays or corpuscles.

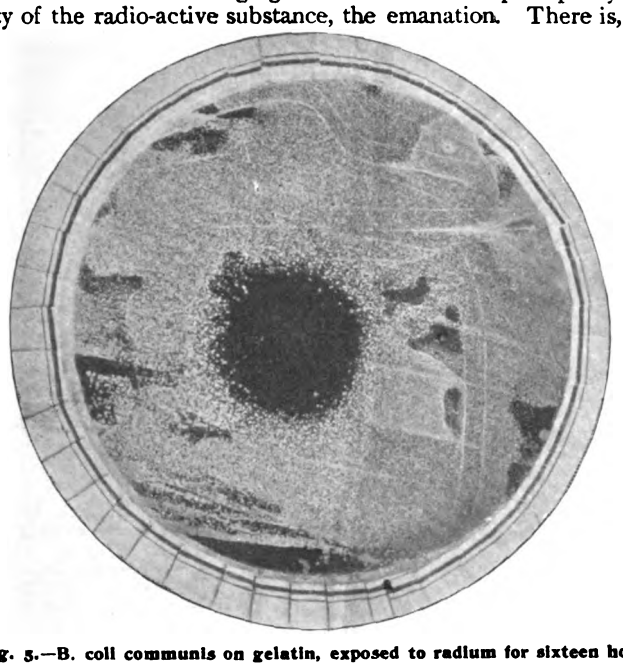

Fig. 5.—B. coli communis on gelatin, exposed to radium for sixteen hours.

Professor Rutherford's suggestion is as follows:—Suppose that the atoms of Radium or Thorium are continually disintegrating, breaking down. As each atom disintegrates, the parts projected into space constitute the rays. The new system that remains is the "radio-activity"—the Radium X* or Thorium X. The new system being also unstable, in turn breaks up, emits its ray, and there is left the second new system—the emanation. But whereas only an indeterminately minute fraction of the whole number of atoms of the original Radium or Thorium atoms change their form in a second, a day, or a week, the Thorium X system changes, disintegrates much more rapidly. The radiations and the power of giving an emanation decay with comparative rapidity. Both the radiations and the power of giving an emanation decay at the same rate. The emanation, in its turn, produces the excited radio-activity—the third change, and the third new system of the atomic constituents—and so the process goes on to the unnamed fourth system. At the first change the breaking down of the original atom, we have α rays shot out*; at the second and third changes we have, when the systems break up, the β rays and their attendant γ rays.

* "Radium X" is only used as a term to signify the state of matter analogous to "Thorium X"; its separate existence is only theoretical, and is to be inferred by the increased activity of Radium salts on precipitation from a solution.

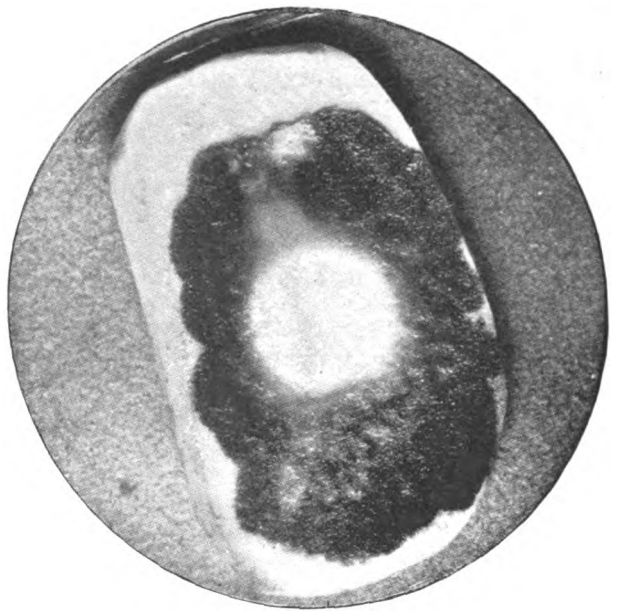

Fig. 6.—B. prodigiosus on potato, exposed to radium for twenty-four hours.

Every atom contains, in Sir Oliver Lodge's words, within itself some seeds of decay; we ought not to assume that any atom is eternally permanent. It seems as if we might find a rise and decay in matter; as if we could write a kind of history of any given piece of matter, and find it ultimately dying down, perhaps into electrons—in somewhat the same way as a nebula contracts and collapses into planets and into a central radio-active sun. By some such process it may be surmised that there have been generated the chemical elements.

We may connote with these theories some plates of the highest interest, which were exhibited by Mr. Henry Crookes, A.R.S.M., F.C.S., at the soirée of the Royal Society, to show the bacterial effects of Radium. Various cultures of bacteria were exposed to the action of 10 milligrams of Bromide of Radium, through a mica screen, at about one inch distance from the surface of the plate. After having been subjected to the action of the Radium emanations, "electrons" in these cases, the plates were incubated for twenty-four, forty-eight, or more hours. In every case it was found that the microbes were killed where they had been exposed to the Radium, so that, on incubation, a bare space, free from bacterial growth, was left on the plate opposite the point where the Radium had been placed. The bacteria exposed to experiment were the *Bacillus liquefaciens*, the *Bacillus coli communis*, and the *Bacillus prodigiosus*. The cultures were on gelatin, on potato, and in agar solution. The results can be seen in the photographs, for which we are indebted to Mr. Henry Crookes.

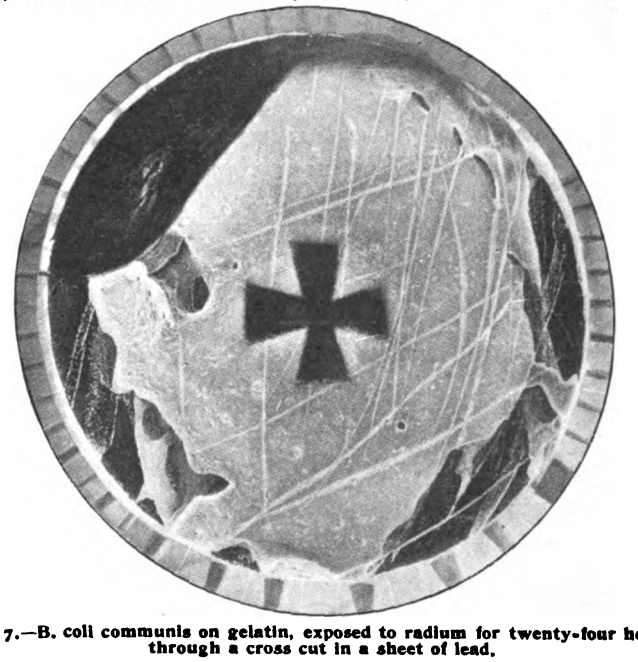

Fig. 7.—B. coli communis on gelatin, exposed to radium for twenty-four hours, through a cross cut in a sheet of lead.

* On this view the spontaneous heat emission of Radium Chloride, which Professor Curie demonstrated, is explained on the hypothesis that it is caused by the internal bombardment of the α particles shot off and absorbed in the mass of the substance.

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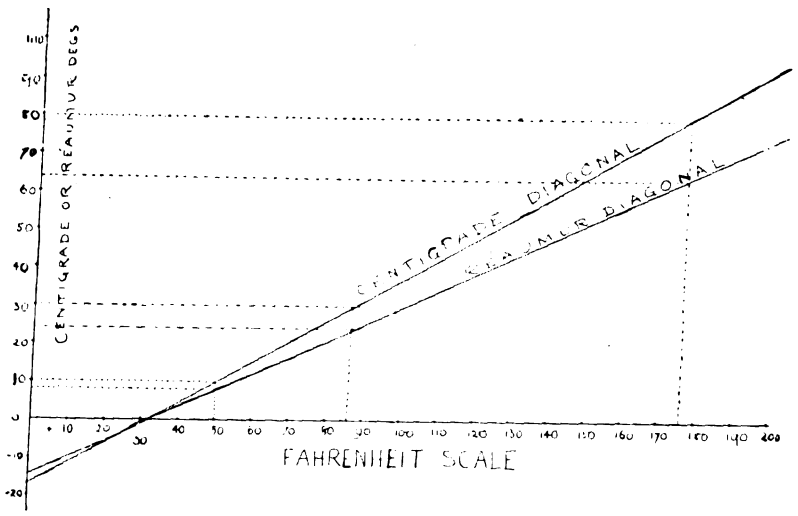
Fahrenheit, Centigrade, and Reaumur.

A CHART is given herewith which suggests a rapid means of transforming readings on the thermometric scales of Fahrenheit, Reaumur, and Centigrade, and is based on a similar chart which appeared in our New York contemporary, *Science*. The relations between the three systems are given by the following formula:—

$$F^\circ = \tfrac{9}{5} C^\circ + 32^\circ$$
$$F^\circ = \tfrac{9}{4} R^\circ + 32^\circ$$

The Fahrenheit degrees are plotted along a horizontal axis, and Centigrade or Reaumur degrees along a vertical scale, and the curves of the two equations give two straight lines as in the diagram. From this diagram, having given a reading in one of the systems, the corresponding reading in either of the other two systems may be obtained.



A scale by which the degrees on the thermometric scales of Fahrenheit, Centigrade, and Reaumur may be interchanged.

Thus, to find the equivalent of 64 deg. Reaumur, the horizontal line from the 64 degrees division on the vertical axis is followed to its intersection with the line marked Reaumur, and thence downward to the Fahrenheit reading on the horizontal axis (= 176 F), or upward to the Centigrade diagonal, and thence horizontally backwards to the left until the vertical axis is reached, where the corresponding Centigrade reading (= 80 degs. C.) is found.

Both lines cross the horizontal or Fahrenheit axis at the same point, 32 degs.; the Reaumur line having a slope of $\frac{9}{4}$, the Centigrade line having a slope of $\frac{9}{5}$.

The diagram is capable of being extended as far as may be desired, and by shifting the origin of coordinates, and choosing a suitable scale of magnification, almost any desired degree of accuracy may be obtained for readings along any given part of the diagram. We should add that our own diagram is intended merely as a sketch of the plotted chart to be made on squared paper.

Rankine and the Metric System.

SOME months ago, the kindness of Sir Frederick Bramwell enabled us to print in the *Illustrated Scientific News* the objections which Napoleon drew up to the metric system. Sir Frederick Bramwell, at a discussion at the Institute of Electrical Engineers, quoted also Rankine's opinion on the same system of weights and measures, and mentioned that Rankine once burst into verse on the subject. Rankine's famous poem we are now able to reproduce:—

THE SONG OF THE THREE-FOOT RULE.

When I was bound apprentice and learned to use my hands,
Folk never talked of measures that came from foreign lands;
Now I'm a British workman, too old to go to school,
So whether the chisel or file I hold, I'll stick to my three-foot rule.

Some talk of millimetres, and some of kilogrammes,
And some of decalitres to measure beer and drams;
But I'm a British workman, too old to go to school,
So by pounds I'll eat and by quarts I'll drink; and I'll stick to my three-foot rule.

A party of astronomers went measuring the earth,
And forty million metres they took to be its girth;
Five hundred million inches, though, go through from pole to pole,
So let's stick to inches, feet, and yards, and the good old three-foot rule.

The great Egyptian Pyramid's a thousand yards about,
And when the masons finished it they raised a joyful shout;
The chap that planned the building, I'm bound he was no fool,
And now 'tis proved beyond a doubt he used a three-foot rule.

Here's a health to every learned man that goes by common sense,
And would not plague the workman on any vain pretence;
But as for those philanthropists who'd send us back to school,
Oh *bless* their eyes if ever they tries to put down the three-foot rule.

The Velograph.

A Recording Apparatus for Vehicles in Motion.

THE Velograph, an apparatus primarily intended for checking the day's work of the carters of the large manufacturing and distributing firms, will probably be found of great use in determining the rate and the distance traversed by motor cars. In view of the attacks that have been made upon motorists in certain parts of the country, an apparatus that shows these things in unmistakable terms should be of considerable value.

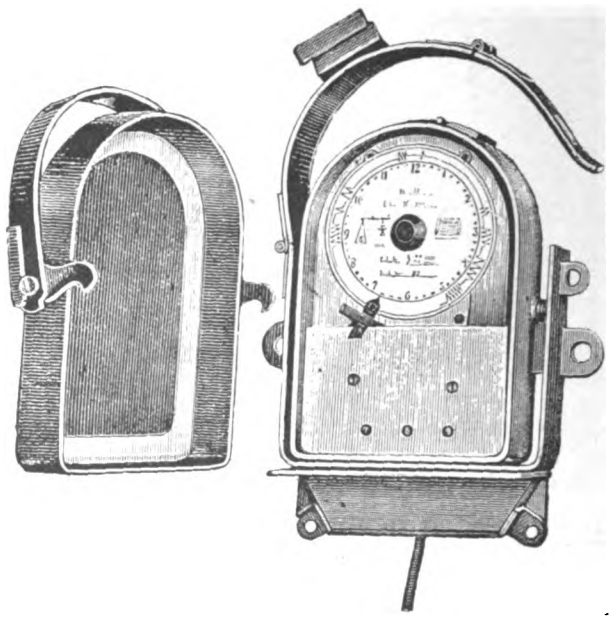


Fig. 1.—The recording apparatus, as arranged to be fixed on the side of the vehicle. The end of the flexible shaft is seen passing into the instrument, and the pencil is also seen between 6 and 7 o'clock.

The Velograph is essentially a clever adaptation of the well-known principle of a revolving clock-face, with a paper dial attached, and a pencil moving over the dial, to the case of moving vehicles. The complete apparatus is shown in Fig. 1, as it appears on the side of

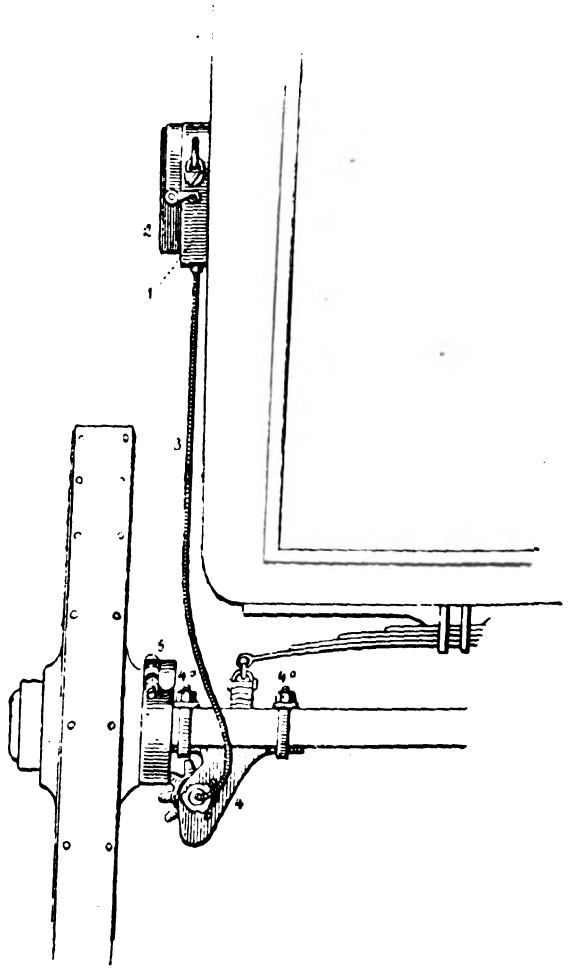


Fig. 2.—Showing the recording apparatus attached to the side of the vehicle (1 and 2), and the transmitting apparatus (3, 4, and 5), consisting of the hub ring (5), the pinion escapement wheel (4), and the flexible shaft (3).

the vehicle, to which it is clamped by means of screws passing through the lugs shown. The portion of the apparatus which receives the motion of the wheel shaft, and transmits the motion to the pencil on the dial, is shown in Figs. 2, 3, and 4. As will be seen, it consists

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of a steel ring of the form shown, engaging with the teeth of a pinion wheel, the teeth being made long, and the distance between their ends rather large. The hub ring, as it is called, is clamped to the hub of the wheel on the same side of the vehicle as the clock is placed, and the pinion with its bracket is clamped to the shaft of the same wheel. Connected to the pinion wheel, and receiving motion from it, is a

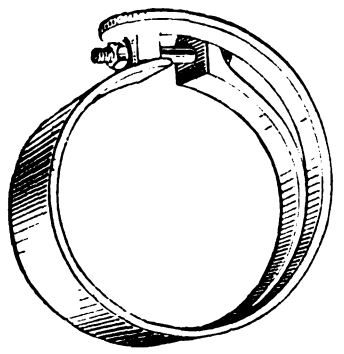

Fig. 3.—Showing the hub ring detached from the wheel.

flexible shaft, similar to those now so often used in connection with portable electric drilling machines, the other end of the flexible shaft being attached to the pencil. As the wheel of the vehicle revolves, the hub ring moves round with it, a tooth of the pinion wheel, which is really an escapement wheel, resting on the portion of the hub ring which is nearest to it, and the pinion wheel being moved round by the pressure of the hub ring on the tooth of the pinion wheel.

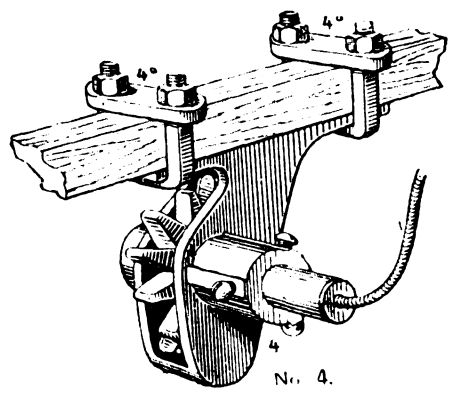

Fig. 4.—Showing the pinion escapement wheel with its bracket, the method of attachment to the wheel shaft, and the flexible shaft.

The movable pencil runs over an annular space on the paper dial on the clock-face in the usual manner. When the vehicle is at rest, the clock, the paper dial, and the pencil, move round uniformly, the pencil resting on the edge of the dial, making a circular line. When the vehicle is in motion the pencil moves inwards towards the centre of the dial, as the hub ring moves round, till when a distance of one mile has been traversed, the gap in the hub ring releases the tooth of the pinion that it has been in connection with, and the pencil returns to the line of rest, from which it at once commences to move inwards again, impelled by the motion communicated to the flexible shaft by the next tooth of the pinion wheel. As the paper dial is marked on its circumference with the usual hours and minutes, the time taken to pass over a mile, and therefore the speed at which the vehicle is travelling at any given time can be read off at a glance, and should be incontrovertible testimony as to what the car was doing. The distance traversed in any given time, including stoppages, which are all recorded, is also easily obtained from the dial. The dial record is shown in Fig. 5.

The apparatus appears to be exceedingly simple and not liable to get out of order easily, and is quickly fixed to any vehicle. The adaptation of the flexible shaft to this work strikes the writer as particularly good. The apparatus is made by Velograph Ltd., Berlin, the London agents being the Berliner Telephone Co., 117, Queen Victoria Street.

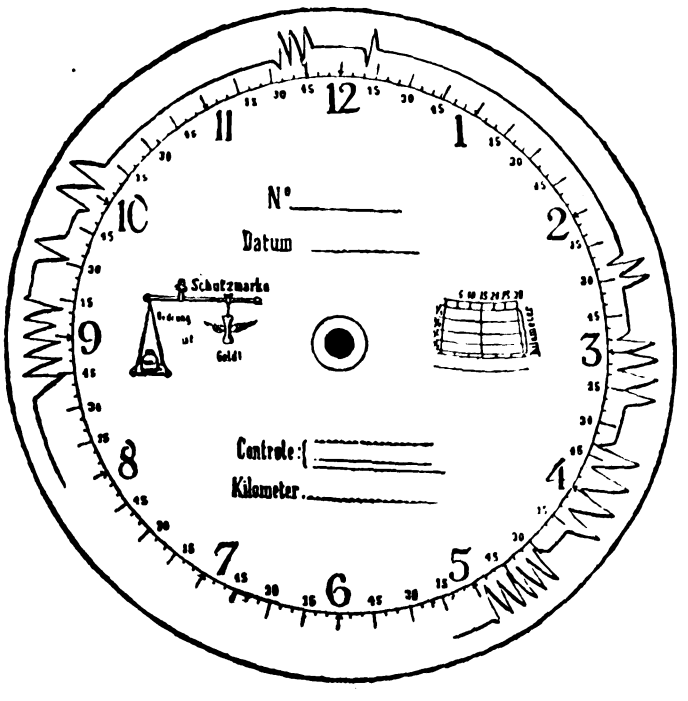

Fig. 5.—Showing the removable paper dial, marked in hours and minutes, and a portion of the line traced by the pencil, in the annular space on the edge of the Dial. It will be noticed that the vehicle was at rest from 8 o'clock to 8.45, that from 8.45 to about 9.17 it covered 5 miles, was at rest till 9.28 and so on.

London in 1910 and 1920.

FOR the Economic Section of the American Association for the Advancement of Science, tables were drawn up showing the probable populations of great cities in the years 1910 and 1920. These tables, which are the work of Mr. Elmer Cottrell, were based on curves which were first made in 1895, and were constructed on certain ascertained rates of increase in the growth of cities. The calculations were revised in 1901, when it was found that the predictions had been justified by the event to a really remarkable extent. In the first table (Table A) are given the populations of the greater cities of the world in the year 1900, together with their calculated rates of increase. In the second table (Table B) are given the estimated populations of cities in 1910 and 1920.

TABLE A.

City.	Date	Population.	Rate of Increase.
London	1900	4,589,129	8·6
Greater London	,,	6,652,145	23·0
Paris (Greater)	,,	3,599,991	18·0
St. Petersburg	,,	1,132,677	15·5
Berlin	,,	1,884,157	12·0
Greater Berlin	,,	2,512,253	19·0
Vienna	,,	1,639,811	11·0
Philadelphia	,,	1,369,632	23·0
New York (Greater)	,,	3,833,999	37·0
New York (Manhattan)	,,	1,850,093	29·0
Chicago	,,	1,838,735	54·0

TABLE B.

City.	Estimated Population in 1910.	Estimated Population in 1920.
Greater London	7,490,400	8,516,256
London	4,967,784	5,315,528
Greater New York	4,953,000	6,191,258
Paris	2,967,030	3,234,063
Greater Paris	4,139,990	4,759,589
Berlin	2,731,820	3,496,729
Greater Berlin	2,914,517	3,322,549
Greater Chicago	2,574,229	3,475,209
Philadelphia	1,697,400	2,002,932
St. Petersburg	1,339,728	1,500,495

Other features of interest are shown by Mr. Cottrell's curves. For instance, the maximum density of London's population is 132,000 a square mile over 357 acres; but the greatest density of population in New York rises to 630,740 per square mile, though this crowding of the population (in tenement houses chiefly) exists only over about three and a half acres. London's average density is 37,000 a square mile, that of New York 40,000 a square mile. Paris is higher than either, with 79,300 a square mile. Philadelphia has the lowest average of population, 8,091 a square mile. St. Petersburg's average is 28,260, and Berlin's, 67,602.

New Poles for Old.

CEDAR and pine trees are rapidly being consumed for the purpose of supplying trolley and telegraph poles, and at the present rate of consumption it will not be a great while before the visible supply will be exhausted. The foresters look to catalpa to fill the place of pine and cedar in this particular. The catalpa has the advantage of growing very straight, and attains the needed size in from sixteen to eighteen years. The time required for cedar and pine is more than double this.

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Some Experiments on Novel Primary Batteries.

By A. JACQUES.

FOR some months I have been experimenting with solutions of thiocyanates—sulphocyanides, as they are often called, with a view to utilizing one of them as a charge for primary batteries.

Ammonium thiocyanate, the cheapest of these salts, would seem at first sight to be decidedly expensive for such a purpose; but, as will be seen below, a small quantity of it can be made to perform a large amount of work.

My first experiment was with (NH_4) NCS* and HNO_3. Using a divided cell, the thiocyanate solution having dipping into it a zinc rod, and the acid a copper plate (the HNO_3 was so dilute that it did not attack the Cn with any visible result), I discovered that a fairly strong current was obtained, flowing from the Cn to the Zn in the external circuit, on joining the poles by a wire.

The E.M.F. of this cell is about 1.4 volts. Its resistance, however, is somewhat high. In order to test its economy and durability, the following experiment was made:—

A Daniell's cell was made up, containing 45 grams of commercial copper-sulphate, and was joined up in series with a galvanometer and a resistance-box, the total external resistance being about 32 ohms.

Another cell, containing 15 grams of (NH_4) NCS, and a small quantity of commercial HNO_3, largely diluted, was similarly connected up, the total external resistance being about 42 ohms. Fig. 1 shows the arrangement.

Each cell lasted for about 15 days—the thiocyanate cell slightly longer than the Daniell. Now, supposing the resistance of the Daniell to be 1 ohm, and that of the thiocyanate cell to be as high as 10 ohms, then

$$C_1 \text{ (from Daniell)} = \frac{E_1}{R_1} = \frac{1{\cdot}07}{33} = {\cdot}0324 \text{ amps.}$$

Watts per hour $= {\cdot}0324 \times 1{\cdot}07 = {\cdot}0347.$

C_2 (from thiocyanate cell)

$$\frac{E_2}{R_2} = \frac{1{\cdot}4}{52} = {\cdot}0269 \text{ amps (nearly).}$$

Watts $= {\cdot}027 \times 1{\cdot}4 = {\cdot}03{,}8$ (nearly).

Thus it is seen that the Daniell is superior to the thiocyanate in current, but inferior in energy, under the above conditions of resistance, when the weight of commercial Cn SO_4 in the former cell is three times that of the (NH_4) NCS in the latter.

The cell containing the thiocyanate, however, slowly exhausts itself when not in use—it may take a month to do so, but the action does go on slowly. The Daniell, of course, under the same circumstances, runs down faster than this.

I now proceeded to try the effect of a film of Cn_2 Fe (CN)6 (cupric ferrocyanide) precipitated within the wall of the porous pot. The result was what might have been expected—the more perfect the film, the higher did the resistance of the cell become; for this substance is the best for use in osmotic experiments, and ions of crystalloids cannot pass through it when precipitated in this way.

I may, perhaps, be allowed to give a brief description of the method of precipitating these films, for those readers who may be interested in the subject.

A porous pot was taken and filled with water, freshly boiled, so that it might be as free as possible from dissolved air. The pot thus filled was allowed to stand for some hours, in order that the water soaking through the pores might expel all the air from the wall of it. Solutions of K_4 Fe (CN)6 and Cn SO_4 were then made and boiled, and the pot, after being emptied of water, was quickly suspended as seen in Fig. 2, and lowered into a large beaker containing the Cn SO_4 sol.; while the solution of K_4 Fe (CN)6 was simultaneously poured into the pot, so that the liquids might meet in the wall of it; for if this point be not carefully attended to, the film is apt to be deposited on the outside or inside surface of the pot, instead of in the wall itself.

As HNO_3 attacks Cn_2 Fe (CN)6, in experiments with these films, I used copper nitrate solution instead of the acid, as being a neutral nitrate with a weak base. The E.M.F. obtained was about the same as with the acid; but in order to prevent hydrolysis, with the precipitation of a basic copper nitrate, it was necessary to add a small quantity of HNO_3. As, however, there was a salt of copper in the outer pot, a small crystal of K_4 Fe (CN)6 was placed in the inner one, so that, should the film be destroyed, it would immediately be re-formed on the contact of the two liquids. In many cells the film was precipitated in this way, as it saved the work of forming it in the manner described above; of course, the film might not be perfect, but it would be formed wherever the liquids met, which was all that was required. Great care had to be taken as to the simultaneous introduction of the solutions.

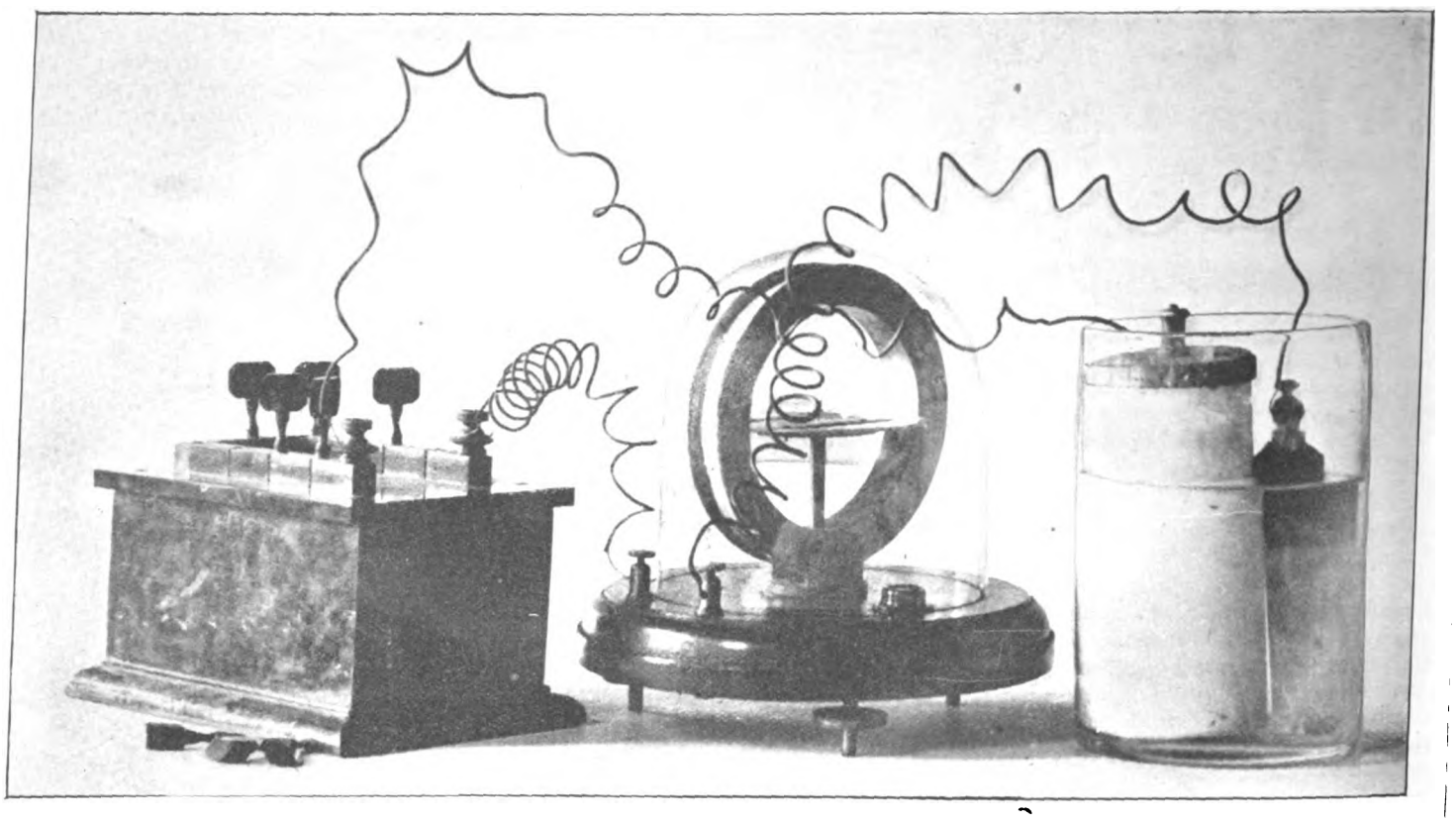

Fig. 1.—Some Novel Forms of Primary Batteries.

On trying the effect of other nitrates upon the current, I found that the strength of it appeared to vary according to the weakness of the base of the nitrate employed. It also varies with the strength of the base of the thiocyanate used.

H_2 SO_4 HC1 may be used instead of HNO_3. The current from the former acid is slightly weaker than that produced with HNO_3 or HC1. The E.M.F. appears to vary also with the strength of the negative radicle of the acid used.

In the case of H_2 SO_4, an unbearable smell of SH_2 is evolved, while HNO_3 gives a slight odour of oxides of nitrogen. HC1 is, perhaps, the best acid to use; it gives a current as strong as that when HNO_3 is used, and no disagreeable odour. The level of the surface of the acid must be kept about 2½ inches above that of the thiocyanate solution, as if this is not so hardly any current is obtained; but if the cell is started with the levels of the solutions thus, no further attention is needed to keep them right.

In the case of HNO_3, a red colouration is produced in the thiocyanate solution soon after the action has commenced, and it remains until the cell is nearly exhausted, when it entirely disappears. The colour is also discharged if the liquid be boiled in a test tube. It is

* There are no true cyanates or thiocyanates; the formula for ammonium thiocyanate is probably best written thus: $(NH_4)-N=C=S$. In all cases where the constitution of a cyanate can be determined, it is found that the cyanogen is in the iso-state, and the oxygen (or sulphur) is attached to the carbon atom at the end, as shown.

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not due to the presence of ferric iron*, for it is seen when acid is used which has been distilled in apparatus entirely of glass.

The zinc is very slightly attacked; an aluminium pole was tried instead of the Zn one, but the result was far from satisfactory. It is necessary that the positive element should be a strong metal.

In precipitating the films of Cn2 Fe (CN)6 in porous pots, I discovered that with a carbon plate in the Cn SO_4 sol., and a Zn one in the K4 Fe (CN)6, a current was obtained about as strong as that from the thiocyanate cell. K4 Fe (CN)6 is cheaper than (NH_4) NCS, and this cell, if tried, may be found to be extremely economical. But as the former salt comes under the poisons regulations some difficulty may be experienced in obtaining it for use in electric

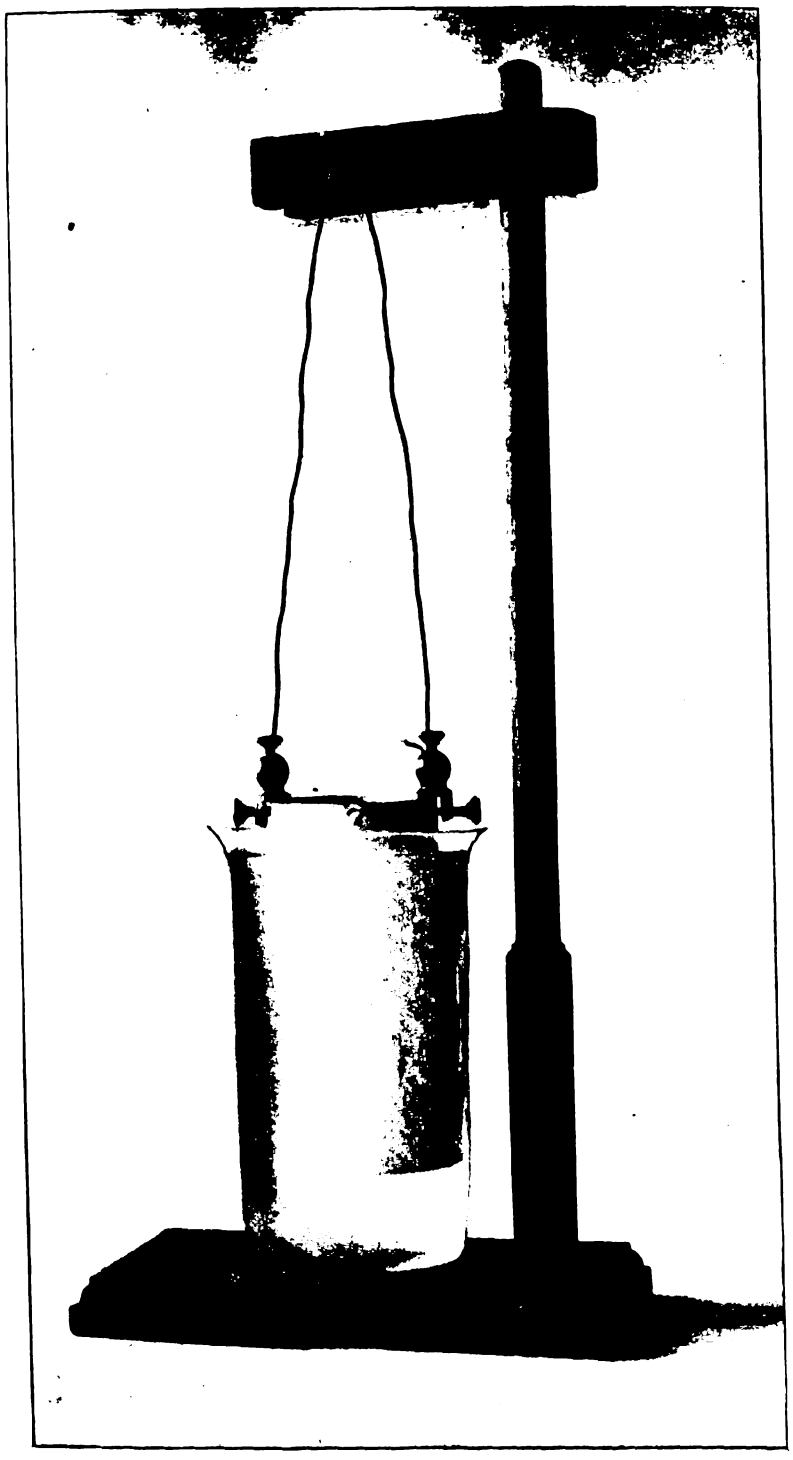

Fig. 2.—Some Novel Forms of Batteries.

batteries. H (CN)—"prussic acid," will, of course, be liberated in the action of this salt; it will dissolve in the water, but I leave it to any readers to judge of the safety of such a cell, which depends upon circumstances. The same acid may be formed more or less in the thiocyanate cell, but I have had no trouble with fumes from it; still, it is, perhaps, safest to pour in the solutions when required, and store them away again until the next time; this will be found in many cases the best plan to adopt, on account of the slight action when in open circuit. But the cyanogen is probably destroyed entirely, and even if a small quantity of HCN is formed, the extremely weak aqueous solution will be harmless so far as fumes are concerned, under ordinary circumstances.

I trust that this cell may be found useful and efficient for general purposes. I think it is particularly suitable for circuits of high resistance, as its own is often somewhat large.

* Soluble thiocyanates form an excellent test for ferric iron, as the presence of a minute quantity of it in solution causes a deep red colouration on the addition of the thiocyanate, owing to the formation of ferric thiocyanate—Fe (SCN_3).

Astronomical Notes for July

THE SUN.

ON the 1st day of the month the Sun rises at 3 h. 48 m. a.m., and sets at 8 h. 18 m. p.m., the length of the day being, therefore, just 16 hours 30 minutes. There is still no *real* night in the British Isles until after the 20th. On the 3rd the Earth will be in *aphelion* (*i.e.*, at her greatest distance from the Sun) at 4 h. a.m. The Sun's apparent declination at noon on the 1st will be 23° 10′ 44″ N., with an hourly variation of 9″.11, his R.A. on the same date being 6 h. 36 m. 51 s., the hourly variation being 10.35 secs.

After the brief period of sunspot-activity in March and April, the solar surface has again become remarkably quiescent.

THE MOON.

Our satellite will be at her first quarter on the 1st, at 9 h. 2 m. p.m., and becomes full on the 9th at 5 h. 43 m. p.m.; she reaches her last quarter on the 17th at 7 h. 24 m. p.m., and becomes new on the 24th at 0 h. 46 m. p.m. She attains her first quarter for the second time this month by the 31st, at 7 h. 15 m. a.m. The Moon will be in apogee on the 10th, and in perigee on the 25th. When the Moon is at her first quarter at the beginning of the month she will *set* at 11 h. 38 m. p.m.; when full she will *rise* at 7 h. 42 m. p.m.; and at the period of her last quarter she will *rise* at 11 h. 17 m. p.m. On reaching her first quarter again, at the end of the month, our satellite will *set* at 11 h. 9 m. p.m.

Occultations will occur (1) on the 9th, when ρ^1 Sagittarii (magnitude 3.9) will disappear behind the Moon's disc at 8 h. 4 m. p.m., at 63° from the true north point, and will reappear at 9 h. 11 m. p.m., at 291° from the T.N.P., and (2) on the 19th, when 38 Arietis (magnitude 5.2) will be occulted at 1 h. 50 m. a.m., at 52° from the T.N.P., and will emerge from behind the lunar disc 57 minutes later, at 272° from the same point. On the 27th a "north near approach" of 79 Leonis (magnitude 5.5) takes place at 8 h. 31 m. p.m.

The Moon will be in *conjunction* with Mars on the 2nd, Saturn on the 11th, Jupiter on the 15th, Mercury on the 24th, Pallas (minor planet) on the 26th, Venus on the 27th, and Mars again on the 30th.

THE PLANETS.

Mercury is a "morning star" till almost the end of the month. He rises at 2 h. 43 m. a.m. on the 10th, with a northern declination of 22° 38′, and a right ascension of 5 h. 59 m. 39 s. By the 26th this little planet will be in *superior conjunction* with the Sun, and, therefore, invisible.

Venus is now a truly splendid object for the unaided eye in our evening skies, in the west, though, as a subject for telescopic scrutiny, she is apt to prove somewhat disappointing, owing to the great glare of her brilliantly scintillating disc. This inconvenience, however, can, to a large extent, be obviated by observing this planet as soon after sunset as possible, and whilst there is yet plenty of light in the sky, as this tends to prevent the glare of the planet herself from hindering observation. On the 10th, at 3 h. a.m., Venus will be at her *greatest elongation east* of the Sun (46°). On the evening of the 9th she will set at 10 h. 15 m., with N.D. 11° 16′ and R.A. 10 h. 19 m. 6 s. On the occasion of this planet's conjunction with the Moon on the 27th at 5 h. p.m., she will make a very near approach indeed to our satellite, Venus being only 43′ (or less than 1½ "moon-breadths") north of the Moon.

Mars will be in *quadrature* on the 6th at 10 h. p.m. During the month he sets between 10 h. and 11 h. p.m., with a disc whose apparent diameter diminishes to 7″.2 by the 30th. On the 23rd he will be in close proximity to *a* Virginis (Spica).

Jupiter, whose apparent diameter is now 42″.0, rises on the 20th at 10 h. 3 m. p.m., with S.D. of 3° 55′, and will prove an interesting object in telescopes of very moderate power and aperture. The planet will be *stationary* on the 14th at 9 h. p.m.

Saturn is now visible for practically the whole night, rising at 8 h. 42 m. p.m. on the 16th, with S.D. 19° 5′, and R.A. 23 h. 37 m. 31 s. He is almost stationary in the constellation *Capricornus*. The remarks above made with reference to the ease with which Jupiter may be observed telescopically apply equally to Saturn.

Uranus, whose tiny disc will have almost imperceptibly shrunk to 3″.6 by the 30th, will *south* on that date at 8 h. 56 m. p.m., with S.D. 23° 22′, and R.A. 17 h. 25 m. 24 s.

Neptune, for our present purposes, remains practically invisible.

THE CONSTELLATIONS.

At the commencement of the month, if we face due south, the constellation Hercules will appear almost overhead, directly below him being that of Ophiuchus, whilst just to the eastward Lyra will be found. In this last-named group, between β and γ, can be observed, on and about the 24th, an annular nebula which is considered the finest known example of ring nebulosity. Encircling Ophiuchus (the "Serpent-holder") on his lower side will be found the Serpent, whilst slightly to the west of the meridian, and in close proximity to the horizon, the Scorpion may be observed.

Turning to the north, Auriga will be seen with her chief brilliant (Capella) approaching the meridian. Perseus and Andromeda are on the north-eastern horizon, whilst the Great Bear will be found fairly high up in the north-west.

The "Milky Way" is well placed for observation at this season, running right across the sky in a gentle curve from south to north.

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The Telephonic Ray.

BY DR. ALFRED GRADENWITZ.

IN a lecture lately delivered in Berlin, Herr Ernst Ruhmer drew attention to the remarkable alterations of the electrical conductivity of selenium under the influence of light. Selenium, as is known, is an element closely related to sulphur, along with which it is always found to occur. Like sulphur, it occurs in several modifications, the most stable form being an amorphous red powder, which, by melting, is converted into a black mass, analogous to sealing-wax. In both of these states, selenium is an insulator of electricity, whereas a third modification, as produced by heating the black form of selenium, is found to exhibit a certain conductivity, which may be strongly increased by exposing this slate-grey modification to the action of light.

It will be easily understood that inserting a selenium rod in this state in an electric circuit will give a means of producing alterations of the current intensity in the latter. Herr Ruhmer, to whom are due most of the developments taken by the selenium industry, has, after many-year long endeavours, finally succeeded in imparting to these selenium rods or cells, as they are called, a very high degree of sensitiveness. It is safe to state that his selenium attachments of average sensitiveness are able to take any conductivity between the initial and a 10-fold value, according to the intensity of the illumination to which they are exposed, whereas the most sensitive instruments will vary up to 100 times, and more, their original conductivity. Moreover, there is no residual effect worth mentioning, so that the selenium cell will instantaneously return to its initial state, if the light be taken away.

In order to diminish to the highest possible degree the resistance of the selenium rods, and hence the difficulties of experimenting, rods of a cross-section as large as possible are being used. Different types of selenium cells have been constructed of late years, the cylindrical exhausted glass bulb type being the most suitable for the purposes of wireless telephony. The author illustrated the sensitiveness of a similar cell by means of a rotating perforated disc, allowing of the selenium cell being intermittently illuminated. As the cell was connected to a battery and a microphone, the fluctuations of the resistance of the cell, as produced by the intermittent illumination, would be converted into corresponding variations in the intensity of the sounds produced by the microphone.

A novel feature demonstrated by the author was the direct electromotive effect of selenium cells, as recently discovered by Herr Ruhmer. He has succeeded in constructing cells capable of producing electromotive forces as high as ½ volt under the influence of a strong illumination; this result means, perhaps, the first step towards solving the problem of a direct conversion of luminous into electrical energy.

Good results have recently been obtained with using selenium for photographic purposes, as evidenced by excellent galvanoplastic reproductions of photographs, whereas electrical telephotography and teleoptics are still in an experimental stage. Among other applications of selenium cells, we may mention automatic lighting contrivances, which have given the most satisfactory results. The most important application of selenium, however, is its use in light or flame telephony.

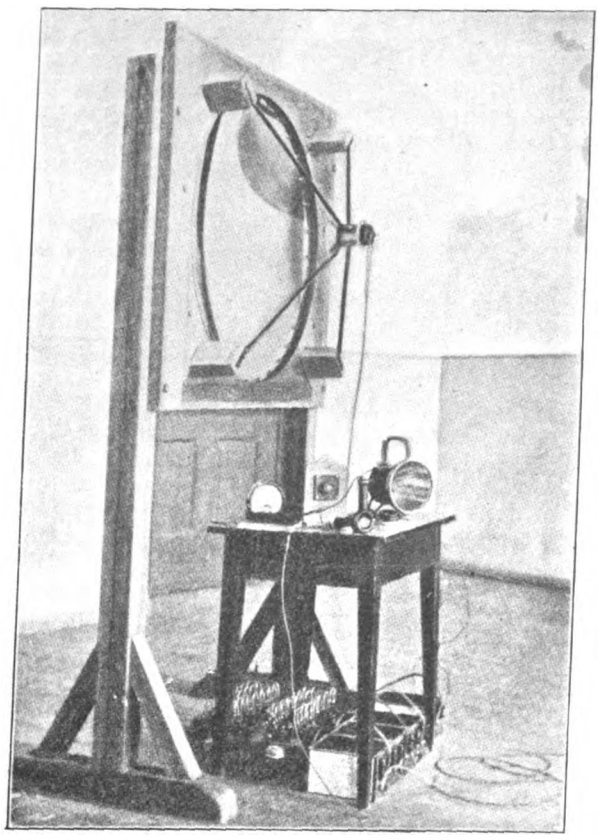
The fluctuating rays of a "speaking" arc lamp are made parallel by means of a projector and transmitted to the receiving station, where a parabolic mirror will concentrate them on a selenium cell located in its focus, when the fluctuating illumination will be re-converted in the telephones connected with the selenium cell into sonorous waves, analogous to those striking at the sending station the microphone membrane of the "speaking lamp" attachment.

With the well-known Wannsee experiments, last year, excellent transmissions were obtained over distances up to 4½ miles, whereas tests now being made have extended by far these limits.

In the Wannsee experiments mentioned by Dr. Gradenwitz, Herr Ruhmer employed an arc lamp with a flaring arc 6 to 10 millimetres long, using an E.M.F. of 220 volts. The current varied from 4 to 5 amperes at 1 to 2 kilometres to 12 to 15 amperes for 5 to 7 kilometres, and the resistance of his selenium cell was 120,000 ohms in the dark, this falling to 600 ohms in full sunlight. For the transmitting end, Mr. Ruhmer employs a carbon transmitter and a battery superimposing waves on the arc light circuit; and the beam of light is reflected to some distant point, where it is received by a parabolic reflector, in the focus of which is placed a selenium cell connected with a battery and a pair of very sensitive telephone receivers.

[Ruhmer's latest type represents, probably, the most important development which has been made in the selenium cell, and it has now become most stable, and responds most rapidly to variations in illumination. He employs two copper wires, wound spirally side by side around a cylinder of porcelain, which, after the wires have been covered with selenium, is placed inside of a globe, which is exhausted. The cylinder is mounted with a butt similar to an Edison incandescent lamp, and resembles a candelabra lamp. This makes a most convenient method of handling the cell; and by keeping it from the air the disadvantages inherent in all cells heretofore have been very largely done away with.

[Our illustrations are reproduced from the *Scientific American*. —Editor, I. S. N.]



Receiving Station of Ruhmer's System of Light-Telephony.

Ruhmer's Station on the outskirts of Berlin, showing the huge mirror.

The Modern Stone Man.

AT the Ladies' Soirée of the Royal Society, an interesting exhibit was a case of arrow-heads and spear-heads, which a casual observer might have taken to be the work of some neolithic artificer, who had taken jade, quartz, and the purest flint to work upon. The specimens were exhibited by Dr. Henry Woodward, who explained that the spear-heads were the work of the aborigines inhabiting the North-West Territories of Western Australia. For the manufacture of their prehistoric weapons they employ such materials as civilisation has put within their reach, glass bottles, and the porcelain insulators of telegraph wires. Only one of the implements shown was made of flint. Nevertheless, these savages of to-day adhere closely to the ancient form and workmanship common to prehistoric man all over the world. There is a small trade in these spear-heads, and their manufacture is occasionally carried on by the aborigines in prison.

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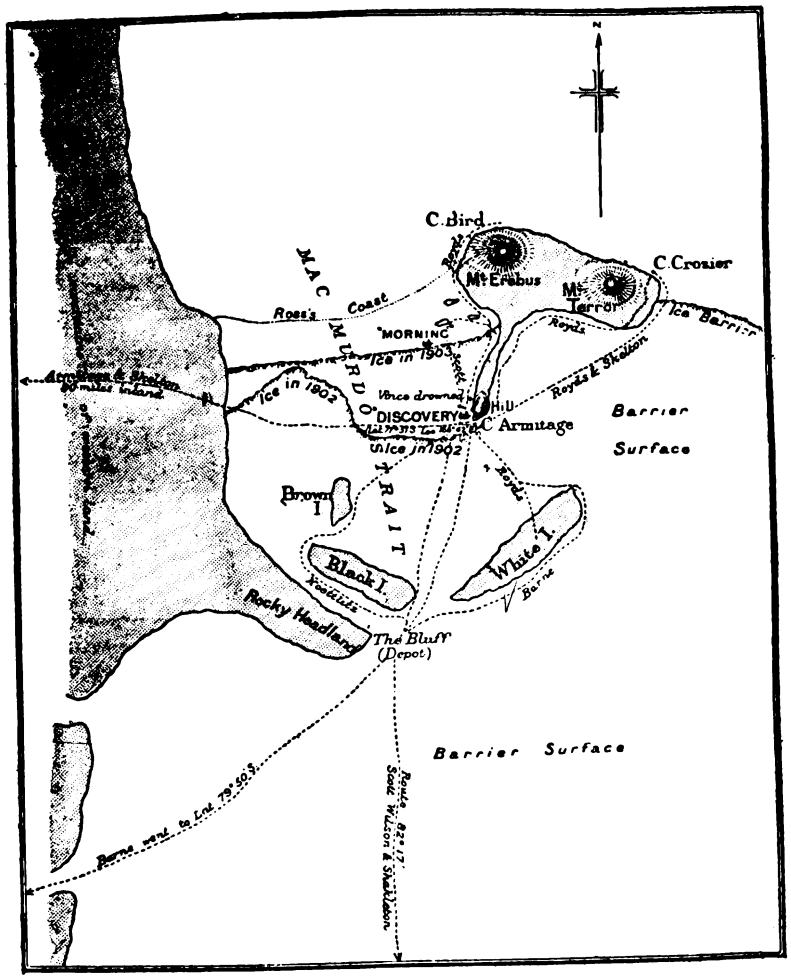
The Position of the "Discovery."

THROUGH the kindness of Dr. Scott Keltie we are able to reproduce from the last number of the Journal of the Royal Geographical Society a chart showing the position of the *Discovery* in the Antarctic, and indicating also to some extent the character and extent of the exploration conducted by those on board the vessel. Among the most important geographical results of the expedition are the discovery that Mounts Erebus and Terror form part of a comparatively small island, the so-called McMurdo Bay being in reality a strait—and the establishment of the fact that a great continental mass of inland ice extends westwards from the coast at an altitude of 9,000 feet. "It was," says the *Journal*, "during the sledge expedition of Lieut. Armitage and Lieut. Skelton that this ice-sheet was ascended, the accomplishment of the feat entailing the greatest difficulties. The party had no dogs, and were obliged to drag their own sledges, which had to be continually unloaded, lowered down into crevasses 50 to 60 feet deep, and hauled



up on the other side. Arrived at the summit, one man suffered severely from the rarefied air. The extensive character of the land discovered during Captain Scott's southward sledge journey seems fully borne out by the further details received, and the mountain ranges which traverse it are said to reach a height of 14,000 feet. It appears that the land discovered at the eastern end of the ice-barrier is distinct from the southward extension of Victoria Land, and Captain Scott proposes to name it King Edward VII. Land."

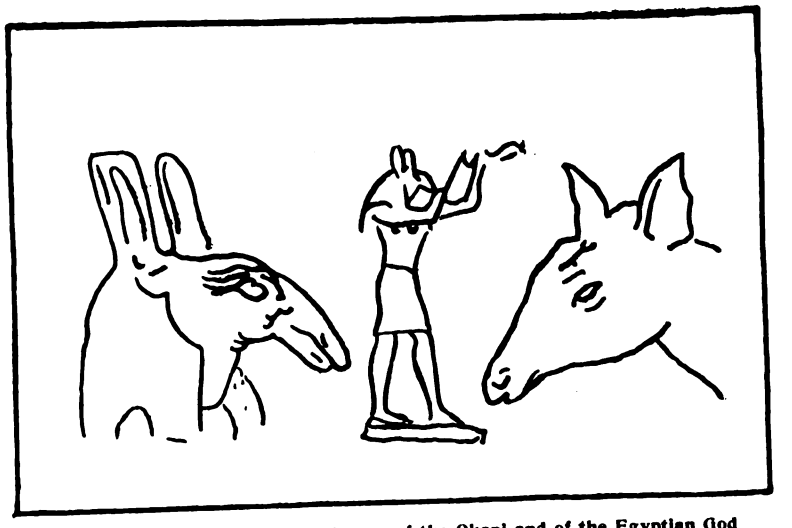
The value to science of the work done by the explorers of the *Discovery* is far from being measured or defined by the mere statement of the explorations conducted, just as the gallantry and spirit of the explorers are impossible of estimation in the mere record of their work. The decision of Captain Scott to make the cruise a three-years' instead of a two-years' expedition is one which has entailed no small sacrifice on the part of himself and his companions; and the gain to science is correspondingly great. When the small amount expended in the encouragement of science by this country is taken into consideration, it would be parsimonious to the verge of stinginess to grudge the £12,000 —which is about the value of the prize won by a horse in the Eclipse Stakes—necessary for the completion of this work.

Diphtheria Lozenges.

THE anti-diphtheria serum discovered by Prof. Roux, of the Pasteur Institute, is now being made in the form of lozenges for use during convalescence. The professor had observed that bacilli found in the mouths of patients several weeks after recovery were liable to convey the disease to others. The lozenges overcome this and also render preventive inoculation unnecessary.

The Okapi in Egyptian Art.

SIR HARRY JOHNSTONE'S recent discovery of the Okapi, an animal believed to resemble the extinct Helladotherium, is still fresh in the minds of naturalists. Something similar to the Okapi's head is discoverable in ancient Egyptian art. Among the gods whom the



The Okapi in Egyptian Art—Figures of the Okapi and of the Egyptian God with the Okapi head.

Egyptians loved to represent as adorned with the heads of animals, one finds the god Set, brother and murderer of Osiris, who wears a very characteristic Okapi head. One might gather from this that the Egyptians had known the Okapi, which, during the last twenty or thirty centuries, disappeared from the Nile Valley and took refuge in the solitudes of the Congo highlands.

Telegraphic Communication in India.

SOME curious facts incidental to the maintenance of telegraphic communication in India have been contributed to the *Engineering Times* by Mr. H. Hervey, a retired official. Telegraph wires in that country have to encounter all kinds of odd enemies, from insects to human beings. One of the most serious of the former is the White Ant. Telegraph posts were formerly usually made of wood, with a notch at the summit to hold the wire, which was not insulated. Thus, when the white ants laid siege to one of these wooden posts, it soon fell a victim to their attacks, either leaving the wire swinging, or bringing it to the ground, when the signals would be weakened if not interrupted altogether. Subsequently, the posts were furnished with backs, brackets, and insulators, at each of which the line was bound with binding wire. On one occasion, when a post was to be supplied with a new insulator, the line-man mounted his ladder and began to unbind the wire, when the post and the ladder with it immediately collapsed. The post was found to be a mere shell, the white ants having eaten it quite hollow, while the wire had in the meantime kept it balanced in position. In process of refitting some posts Mr. Hervey found a variety of singular little refugees in the interstices between the insulator cups and hoods—lizards, centipedes, scorpions, and tarantulas, while mice and bats were inhabiting the tubular brackets, and, strangest occupant of all, in rice fields or marshy ground, almost every cap was found on removal to conceal a water snake. The natives are, for the most part, imbued with a wholesome respect for Government property; but the glistening white porcelain insulators, which have now been adopted, present an insuperable temptation to the goat-herd, as a mark for stones, and numbers of them are broken in this way. Apart from damage done out of mere wanton mischief, the natives occasionally steal wire to make snake rods. A snake rod is a very necessary protection in the dark, especially to bare-footed or sandal-shod natives, and telegraph wire threaded through some jangling metal rings makes a most efficient safeguard in scaring away reptiles. Disused wire is sold by auction for this purpose, and fetches a good price; but these auctions are held in the towns and are inaccessible to the remote villager. Birds cause frequent disturbance not only in the case of a large bird's bridging two conductors with its body by sitting on the wires, but in the case of kites by leaving the remains of a meal of entrails "festooning over several wires, or connecting a conductor with the iron of bracket or post"; this, says Mr. Hervey, is a fruitful source of disturbance.

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Applied Science.

THE present-day influence of applied science has been abundantly shown in one of its most important branches by the highly successful International Congress of Applied Chemistry lately concluded at Berlin under the presidency of Prof. Dr. Otto N. Witt. Our German confreres in science know well how to manipulate the laborious initial details attending such gatherings, and how to carry the proceedings to a conclusion both satisfactory and dignified to those concerned. To secure a roll-call from all parts of the world of something approaching three thousand persons is a feat in the organisation of the forces of applied knowledge that speaks for itself. Nowadays we realise that the potentialities of pure science are quickly recognised and forged into the weapons of economic aim and purpose. Liquid air, for example, has reached the hands of the working pathologist, heralding it would seem, according to Prof. Macfadyen, the advent of a method whereby a practical application arises to combat the typhoid bacillus. "Typhoid organisms," he says, "after careful washing with distilled water, were disintegrated in a mechanical contrivance at the temperature of liquid air" (180° C.). One may go further with recent applied science. The other day, at the Royal Society's soiree, Sir William Crookes exhibited a little instrument called the "Spinthariscope," to demonstrate the remarkable scintillations of Radium. This has now stepped out of the laboratory and become a marketable bit of apparatus, and may be purchased in one form with lenses for direct vision, or in another for microscope observation. Thus the brilliant and ceaselessly twinkling Radium effects may be seen of the many. Neither does this conclude the tale of application. Patent rights were acquired early last month by Dr. A. A. Common, the eminent astronomer (unfortunately, since deceased), for the adaptation of Radium in his collimating gun sight for day and night work. It is certainly, for the moment, of singular interest to army men and sportsmen, whatever uses it may ultimately have. The sight consists of a lens mounted in a tube fixed to the top or side of the gun, with a fiducial mark at its focus, and this mark for the eyes is, for night operations, a small screen of Radium, which is, of course, luminous. The prompt transference of laboratory research for the service of man could not be better exemplified.

The International Association of Academies.

THE recent meeting of the Council of the International Association of Academies under the chairmanship of Sir Michael Foster, Sec.R.S., is remindful of the fact that the General Assembly of the Association will be held in the early part of next year in London—it is hoped at Whitsuntide. The gathering promises to be in every respect notable, since eminent representatives from the premier scientific and literary academies of Europe and America will attend the deliberations, in which it is interesting to note the new British Academy for the promotion of historical, philosophical, and philological studies will take part as a constituent body. The first general meeting of the Association, it may be recalled, was held in Paris in 1901, and it was then unanimously decided to hold the second Assembly in England, the Royal Society assuming the position of directing academy for the intervening triennial period. Armed with the authority and advantages of international co-operation, various schemes are already under the guidance of the associated academies, such as the preparation of a complete edition of the works of Leibnitz, an undertaking never before attempted; and the establishment in Paris of an institute for the certification of physiological apparatus. Projects of general utility to science are also before the International Council for reference to the General Assembly, among them a proposal for an organisation for investigating the anatomy of the brain. As regards arrangements for the suitable reception of the delegates in 1904 and their entertainment during the hours of leisure they may enjoy, nothing much can be advanced at present. The French Government and the Municipality of Paris dispensed hospitality two years ago in liberal and in graceful fashion, and, if we mistake not, President Loubet personally received the delegates on one occasion. Without disparagement it may be said that the Congress will obviously stand on a plane altogether different from the composite meetings which are annually held by the British Association and kindred bodies. The French, German, Italian, and other Continental representatives will, in fact, typify the scientific intellect and activities of the countries they come from; and this is equally the case with America. It is to be hoped, therefore, that the English Government will extend its official patronage in view of the precedent already established. No one will doubt also that the two great civic powers of London will welcome the delegates of the world's science at the forthcoming Witenagemot on a scale appropriate to and commensurate with the unique character of the assemblage, and the international aims of the amalgamated academies.

Railway Electrification.

THOUGH it is constantly being pointed out (by the electricians) that the electrification of railways can alone save railways from insolvency, it will probably be many years before the great main lines of Europe or the United States consent to scrap the costly systems which it has taken two generations to build up. Mr. Cornelius Vanderbilt has recently stated the case with the frankness that is characteristic of the millionaire and "the railway king" in the United States. "The only thing we have to consider," he says, "is whether the additional capital outlay will be returned to us by diminished working expenses?" The challenge has been taken up by a writer in the *North American Review*, who endeavours to show that the amount saved in working expenses will be almost double the amount necessary to pay a return at fair interest on the additional capital invested. The basis of comparison of cost of a railway worked by steam locomotives and one worked by electric traction may be divided into five headings. There is (1) the cost of fuel. This may be taken as the same on either system. There is (2) the amount of useful work at the driving wheels derived from the unit amount of fuel. By an elaborate calculation the writer demonstrates that with steam locomotion the cost works out at 3d. a train mile for passenger traffic and 7½d. a mile for luggage trains. With electric traction the cost is 3¼d. for passenger and 6¾d. for luggage trains. The cost of upkeep of roadway (3) is put down as about the same under either system. There remain (4) the cost of handling traffic and (5) cost of machinery repairs. On both these there should be a considerable saving. There are savings to be made in wages, in water supply over a long trunk line, in economy of power (as in the instance of switching engines), and in lighter and more manageable motors. There is also a large saving, it is claimed, in engine repairs. Finally, the writer estimates the cost of converting a great main or trunk line at not more than £1,500 a mile—perhaps £4,500,000 for the New York Central, which, at 10 per cent., would be an annual charge of only £450,000.

Under Pressure.

AT the Royal Society, Mr. Buchanan, F.R.S., exhibited last month the results of an experiment made on board the Prince of Monaco's yacht in order to illustrate the effect of great pressures. The experiment was made by sinking a copper sphere, which enclosed a glass flask, to a depth of 3,000 fathoms in the sea. The copper sphere contained a glass spherical flask of about 1½ inches in diameter hermetically sealed, and the sea-water had free access through the two holes at the poles. The brass tube contained a glass tube of 50 cubic centimetres in capacity, hermetically sealed, and the sea-water had free access at both ends of the brass tube. The brass tube was sent to a depth of 3,000 metres, and at some, probably less, depth the internal glass tube gave way to the pressure and collapsed suddenly. The enclosing brass tube was pinched up by the external pressure. The experiment shows that, in the time, it was easier to pinch the envelope of brass than to shove in the plugs of water at both ends.

The copper sphere was sent first to 3,000 metres, but was pulled up without showing any effect. It was then sent to 6,000 metres, and the internal glass flask collapsed at some depth between two and three miles, and the creasing which is visible on the copper sphere was produced.

These experiments, whether made with the copper ball or with the brass tube, furnish striking demonstrations of the importance of the element of *time* in all physical considerations.

The collapse of the brass tube, under the peculiar circumstances of the experiment, is the exact counterpart of the experiment which is frequently, but unintentionally, made by people out shooting, especially in winter. If, from inattention or other cause, the muzzle of the gun gets stopped with a plug of even the lightest snow, the gun, if fired with this plug in its muzzle, invariably bursts. Light as the plug of snow is, it requires a definite time for a finite pressure, however great, to get it under way. During this short time the tension of the powder gases becomes so great that the barrel of the ordinary fowling-piece is unable to withstand it and bursts.

Phonograph Speech Tracings.

DR. H. LIORET, of Paris, to whom is due the invention of celluloid cylinders for a phonograph he employs, has enlisted the service of Prof. E. W. Scripture, of Yale University, who has constructed an ingenious new machine for tracing off the speech curves produced by the cylinders, and some novel opportunities in experimental phonetics are now available to those desirous of studying the curves due to characteristic French sounds through the tracings of the grooves. The tracings are recorded on a long band of smoked paper passing over two drums, and appear in some magnification. An alcoholic solution of shellac used on the back of the paper effectively fixes the specimens.

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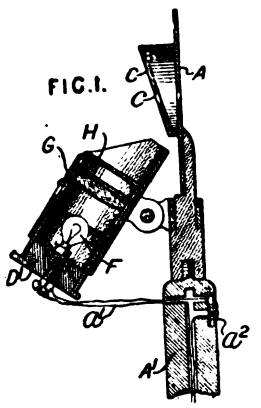
Recent Patents.

2123. Ophthalmoscopes. HARRISON, G., 11, Southampton Buildings, London, W.C.—(*Chamberlin, W. H., Bedford Building, Chicago, Illinois, U.S.A.*) Jan. 27.

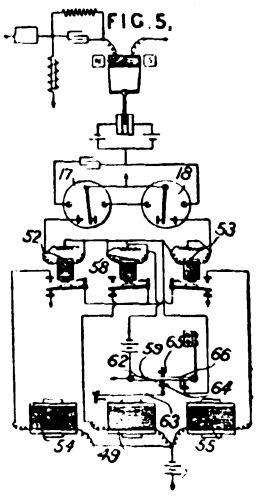
FIG. 1.



Relates to a hand retinoscope carrying its own source of light. A frame A, rotatably mounted on a handle A^1, carries a mirror C with central sight-hole *c* and a pivotted tube fitted with an incandescent electric lamp F and a lens H. The lamp can be adjusted by a sliding tube D^1, and the lens H is similarly adjustable by a sleeve G. Current is supplied to the lamp by leads a^1 and can be cut off by a switch a^2 in the handle. The mirror C may be mounted on gymbals, so as to be adjustable in all directions, and is sometimes imperforate, the sight-hole being formed in the frame A above the mirror.

2310. Electric Telegraphs. MUIRHEAD, A., The Lodge, Shortlands, Kent. Jan. 28. *Patent not yet due for sealing.*

FIG. 5.

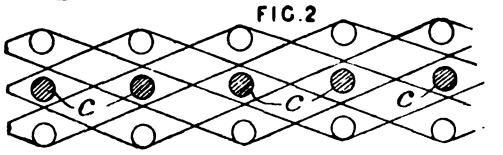


Relates to improvements in siphon-recorder relay systems, in which the message may be received as a perforated strip for re-transmission, or in which the message is directly translated on to a second cable. Reference is made to Specifications Nos. 516 and 7525, A.D. 1899, No. 3343, A.D. 1900, and No. 18,610, A.D. 1901. The signal coil may be curbed by a second coil connected either by light rods and a stretched thread, or by an endless or equivalent thread connected to the second coil and to a disc carried by the bifilar support of the cradle. The signal coil may also be curbed by "overflow" currents when the back stops of the relays 17, 18 are connected to the split battery of the overflow circuit through an artificial line and the second coil. When the apparatus is arranged to operate a perforating-receiver, Fig. 5, the signal relay magnets, 52, 53 are arranged to operate the signal-perforating magnets 54, 55. A space-perforating relay magnet 58 is arranged in relation to the space-perforating magnet 49 so that, as the circuit of one is closed, the other is opened, thus producing a continuous perforating action as long as a message is being received. The armature 63 of the magnet 49 is provided with a rod 62, carrying adjustable stops 64, 65 by which the contact rod 59 is shifted into or out of contact with the stop 66. When desired, a hand key can be substituted for the automatic reception, an additional contact, arranged close under both levers, being employed for operating the magnet 58.

2377. Heating by Electricity. HERRGOTT, J. M. C., Villa de la Sablière, au Valdoie, Belfort, France. Jan. 29.

FIG. 1.

FIG. 2.



Fabrics to be electrically heated contain special threads, Fig. 1, in which fine wires *a* are laid helically round a fibrous core *b*, and then covered with insulating-thread *c*. The wire may be of copper, tinned brass, aluminium or its alloys, or galvanized iron, and the fibre may be hemp, cotton, silk, wool, jute, ramie, or asbestos. The fabric may be woven so as to have both surfaces formed entirely of fibre threads, as shown in longitudinal section in Fig. 2, the wired weft threads *c* being entirely enclosed. The fabric has a double selvage on each side, between the parts of which the looped ends of the wire weft *a* are connected at intervals to longitudinal conductors, by twisting the loops round the latter; the double selvage is closed over these connections, either in the loom or by sewing. The fabrics are specially applicable in the form of endless cloths in drying-apparatus, and for this purpose are provided with metal buttons, which lie on one surface, and are connected with the longitudinal conductors; when the cloths are in use, the buttons travel over stationary contact plates, by which current is conveyed to the heating-wires. The fabrics may be dressed, dyed, printed, or otherwise decorated, and are applicable as domestic heating-appliances, in the form of carpets, cushions, furniture, or hangings, or they may be combined with carpets or tapestries, and they can be used for warming the feet or other parts of the body. The endless cloths are applicable in paper making, dyeing, dressing, or finishing machinery.

REVIEWS OF BOOKS.

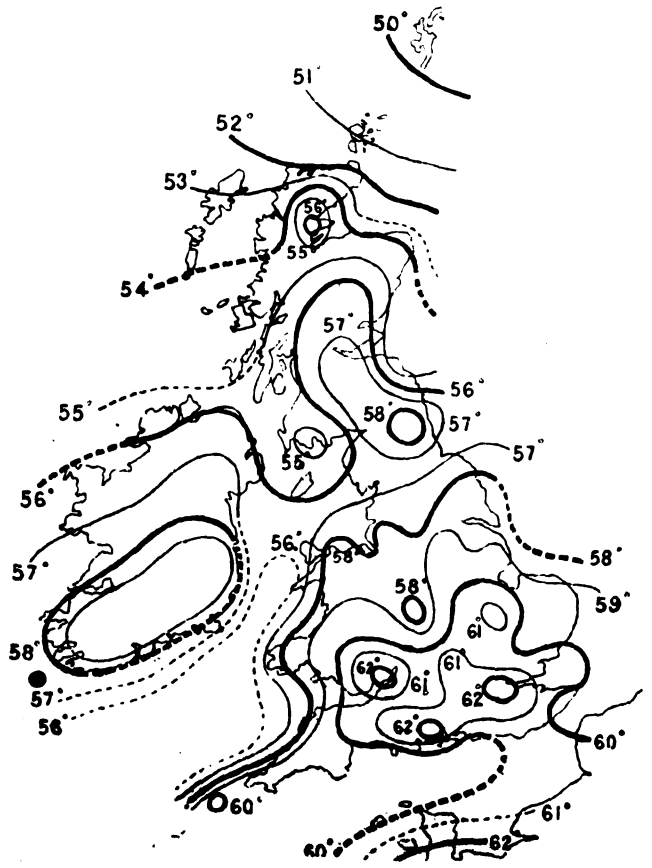
The Macmillan Company publish the first part of Dr. Julius Hann's **Handbook of Climatology,** which has been translated from the German by Professor R. de C. Ward. This, the standard work on climate, after discussing the general aims of the science, deals first with the climatic factors, temperature, atmospheric moisture, winds, evaporation, and the component parts of atmosphere. The second part treats first of solar or mathematical climate, then in great detail of continental, marine, and mountain climates, with special reference in each to certain winds. The third and last part is devoted to changes in climate, geological and periodic.

The treatise upon **Practical Plane and Solid Geometry**, by Mr. Joseph Harrison, now published by Messrs. Macmillan and Co., is designed for elementary students and adapted to the requirements of the revised South Kensington syllabus. It adopts the newly recognised principle that the teaching of decimals in arithmetic should go hand in hand with practical mensuration by a decimally subdivided scale, and that this training in experimental measurement should precede theoretical geometry. And in geometry the pupil is encouraged to check arithmetically results obtained graphically. In short, the object is to educate the learner not in geometry only, but in the principles of mathematics, showing the interdependence of its separate branches.

Owing to the increased demand for Mr. E. W. Maunder's popular work **Astronomy without a Telescope,** only lately issued the publishers have prepared a second impression which is now ready.

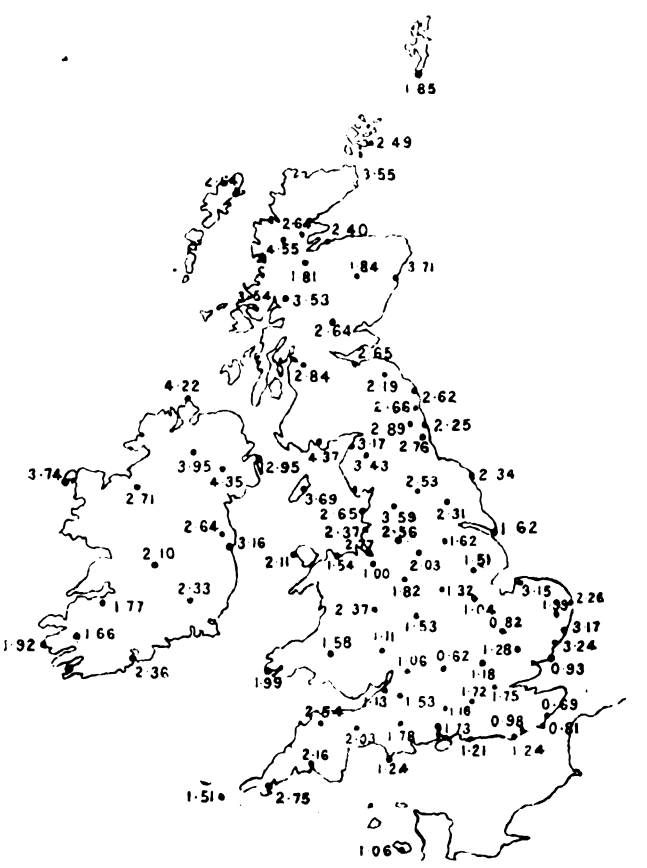
LAST YEAR'S WEATHER.—JULY, 1902.

DISTRIBUTION OF MEAN TEMPERATURE.



Temperature below the average, especially in the Northern and North-Western Districts. Highest reading 87° in London, 86° at Cambridge. Lowest, 40° at several Northern Stations.

RAINFALL.



Generally deficient, but one heavy fall made more than average in N. of Ireland. Largest daily amount, 2·4 in. in Dublin.

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CORRESPONDENCE.

DARWIN AND HIS ASSOCIATES.

To the Editor of "SCIENTIFIC NEWS."

SIR,—In your last number is an article, "The Biological Bent," which implies that Dr. Wallace is the last of those who assisted Darwin in his researches, or as you place it "kept the bridge for the cause of Darwinisin."

There are only three men now living who are mentioned in the first edition of Darwin's Origin of Species, Dr. Wallace, Dr. Hooker and myself. In 1853, the date of its publication, I did not know Darwin personally; I was shortly after introduced to him by Yarrell, when he was surprised to find that I had been working for years at the variation of animals by artificial selection. He visited my house, carried away a vast number of skulls and other specimens, requested my humble aid, sent me the manuscript relating to the subject in his large work on Variation of Animals, and made fifty references to my assistance in that work, inasmuch as I had undertaken numerous experiments in breeding at his request.

As an example of his thoroughness in work, I may state that he requested me to ascertain for him the proportion of sexes at birth in different vertebrates, and he was surprised when I told him that no record of large numbers could be readily obtained, except in the case of the human species, as no reliable records were kept. At his request I employed a clerk to work at the subject inasmuch the records of thoroughbred horses are kept, and I was enabled to ascertain the proportion of sexes in racing greyhounds. This investigation extended for some two or three weeks, and cost Darwin many pounds.

In the two volumes recently published, entitled, "More Letters of Charles Darwin," edited by Francis Darwin and A. C. Seward, of Cambridge, a graceful acknowledgment is made of the services that I had the honour of rendering the great philosopher. Respecting my collection of over one hundred of his letters which I placed at their service, the authors write as follows:—"Mr. Darwin's letters to Mr. Tegetmeier, taken as a whole, give a striking picture of the amount of assistance which Darwin received from him during many years. Some citations from these letters given in 'Life and Letters' show how freely and generously Mr. Tegetmeier gave his help, and how much his co-operation was valued."

They also furnish other examples of the questions on which they are pleased to say "Darwin sought Mr. Tegetmeier's opinion and guidance."

Please do not ignore a friendship which I regard as my strongest claim to be considered as a most humble scientist.

NORTH FINCHLEY, N. W. B. TEGETMEIER.

Prize Competition

ONE of the principal objects of this journal being to encourage and foster the introduction and propagation of new ideas, the Proprietor offers a series of money prizes to those who, in his opinion, send in the best and most practical solutions to certain problems, which will be set each month.

The competitor gaining the greatest amount of marks each month will be awarded the monthly prize of ONE GUINEA. But in order to encourage clever inventors, and not merely reward those who may happen to hit upon a happy idea, a GRAND PRIZE OF **ONE HUNDRED POUNDS** will be awarded—after twelve problems have been sent—to that inventor who shall have gained the greatest aggregate of marks during that period, provided he shall have gained at least *30 per cent. of the full marks* in at least six of the competitions (whether he has gained a monthly prize or not).

RULES.

1. Designs to be sent in to the office before the end of the current month, accompanied by the coupon cut from this paper.
2. The solutions sent in must be concise, yet fully descriptive of the idea intended. To comply with this they must not exceed 300 words, and not more than two simple diagrams should accompany it.
3. Solutions will be published as considered desirable by the editor.
4. Competitors may obtain patent rights for their ideas, but they must run all risk of the publication in this paper interfering with the obtaining of such rights.
5. Competitors may send in their designs under a fancy name for publication, but their true names and addresses must be inserted on the coupon, which, in the event of their winning a prize, will be published. The same fancy name must be adhered to throughout in future.
6. The same person may send in two solutions so long as a separate coupon accompanies each. All marks so gained will count for the grand prize, but the monthly prize will only be awarded for the one best solution. If the two solutions appear to the judge to be but slight variations of the same invention, marks will be deducted from the second solution.
7. Novelty of design is not a *sina qua non* (since this would be extremely difficult to prove), but only the person sending a description with the coupon is entitled to reward.
8. It would add to the value if a statement be added to say if the design has been practically tried; but to corroborate this the inventor may be called upon to give a demonstration before receiving a prize.
9. In the event of an equality of marks or any other exceptional circumstances, the proprietor will decide on the fairest method of distributing the prize.
10. Non-compliance with the above rules may disqualify a competitor.

Photography in Colours.

THE answers in this competition have not been very satisfactory, the judge (who, we may state, is one of the greatest authorities in England on this subject) remarking that they are none of them of any practical value, though a few disclose some ingenuity.

KHARKI (**20.**) The image is focussed on to a screen, in which is embedded a number of thermo-electric couples. These are arranged in rows and are coloured differently. This screen being moved across the field, the various colours affect each couple of the thermopile, which reflects the same colour but absorbs the complementary colour, and the temperature is then slightly raised. Wires connect each couple to an electro-magnet operating a pen, which marks the paper with the desired colour. *It is very questionable if a thermopile could be made to discriminate between the colours of light thrown upon it.*

MEPHISTO, No. 1 (**15**). Three glass plates are placed inside the camera, one behind the other, at such an angle as to reflect the image on to three separate sensitive plates. Coloured filters are interposed. Three positives are produced, each colour being represented as white and its absence as black. *An incomplete version of Ives or Ducos du Hauron's apparatus.*

KASS No. 2 (**5**). A screen is ruled with a number of very fine lines at varying distances apart so that the respective rays of colour may pass, and is applied in the same manner as a Joly or McDonough screen.

K. O. H. No. 1 (**5**). Three plates are exposed in succession, with coloured screens over the lens. Three positives are prepared on gelatino-chloride paper and the prints fixed, which dissolves the portions unaffected. Thus various coloured prints are obtained. *Similar to the method of re-sensitizing films.*

MEPHISTO No. 2 (**5**). Three coloured filter plates are used successively. In front of sensitive plate is a glass plate the surface of which is cut in ribs forming a series of lenses to concentrate the rays into fine lines. This ribbed plate is revolved through 60° between each exposure.

KASS No. 1 (**3**). "A camera for animated photographs" is used, operating alternately coloured screens.

K. O. H. No. 2. (**0**). Six named chemical solutions are applied to four films on the plate. After exposure the film is treated with three other solutions, giving the desired colour to each film. *What the actual result of this mixture would be is impossible to say. Has it been tried?*

The Monthly Prize of One Guinea has therefore been awarded and forwarded to

"KHARKI,"
F. C. SUMMERSON,
Church Street, Walton-on-Thames.

The subject for this month will be—

A CALCULATING MACHINE

of simple form, to multiply and divide.

Coupons to be delivered by July 31st.

COUPON.

To the Proprietor, ILLUSTRATED SCIENTIFIC NEWS.

I herewith forward my idea for a solution of the problem on "A Calculating Machine," according to the conditions published in your paper, and I agree to comply with those conditions.

Full Name .....

Address .....

.....

Fancy Name for publication .....

Date .....

ANOTHER SEPARATE PRIZE OF FIVE GUINEAS

will be given for the best series of

PHOTOGRAPHS OF CLOUDS

Typifying the various varieties—cumulus, cirrus, nimbus, &c.

The series should consist of not more than six photographs, and may be of any size.

They should be sent to our office not later than the *end of September.*

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THE ILLUSTRATED

Scientific News.

A Monthly Journal devoted to Popular Science.

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Continental Physical Notes.

BY DR. ALFRED GRADENWITZ.

The Possibilities of Selenium Cells.

A NOVEL application of photo-electric selenium cells has lately been made by Herr E. Ruhmer, the well-known experimenter in the field of wireless telephony. (See July number of the *Illustrated Scientific News.*) After using his cells to record a partial eclipse of the sun, impossible of being observed directly owing to the heavy clouds prevailing, he now avails himself of the extreme sensitiveness attained in the latest types, in order to *observe a nearly total eclipse of the moon.*

As the resistance of a selenium cell is altered to a very high degree by the action of varying illuminations, the variations in the intensity of the moonlight would give rise to corresponding variations in the resistance, and, accordingly, the intensity of the current traversing the circuit to which the cell was connected. This effect was enforced by means of a parabolic mirror about 45 cm. in aperture, concentrating the light of the moon on the cell placed in its focal axis, so as to produce a uniform illumination of the surface of the cell. In order to be able to adjust the mirror according to the position of the moon at the time, a small telescope with cross-wire was connected with it.

The graphical representation given by Ruhmer shows a gradual increase of the intensity of the current corresponding with the height of the moon, up to a certain point corresponding with the ingression into the penumbra of the earth, when a gradual decrease sets in; as the moon enters the umbra of the earth, this decrease becomes very rapid, the curve reaching a minimum, corresponding fairly well with the maximum of the eclipse, as astronomically calculated. The second half of the curve shows a similar behaviour, allowance being made for the eventually decreasing height of the moon, resulting in a depression of this part of the graphical representation. These experiments show the astonishing possibilities afforded by selenium cells.

Blondlot N-Rays.

Some weeks ago, R. Blondlot communicated to the French Academy of Sciences a note to the effect that Rontgen bulbs will give off certain *radiations analogous to light*, and capable of traversing wood, metals, black paper, etc., some of these radiations having an index of refraction for quartz as high as about 2. Now, the index of quartz for the remnant rays from rock-salt, as discovered by Prof. Rubens, is 2.18. This fact induced Blondlot to suppose that the above radiations are related to the Rubens rays, so as to occur along with the latter in the emission of an Auer burner, which is a source for these rays. Now, recent experiments have shown this prevision to be true; Blondlot has, indeed, been able to state the existence of four kinds of similar radiations, for which the refraction index of quartz takes respectively the values 2.94, 2.62, 2.44, 2.29.

These radiations, as obtained by interposing an aluminium plate in the way of the rays from an Auer burner, are reflected by a plate of polished glass according to the laws of regular reflection, and diffused by a ground-glass plate. They will traverse all the substances tested, excepting rock-salt, for a thickness as high as 3 mm. Photographic impressions are not obtained directly, but by the aid of a small electric spark or a small flame, that will be enforced by the action of these N-rays, as they are termed. The same radiations have lately been found to exist in a beam of solar rays.

A Nebular Hypothesis of Radium.

A somewhat modified hypothesis on the *nature of radio-active bodies* is put forth in a paper by *Filippo Re* recently read before the French Academy of Sciences. It is pointed out that it would be impossible to account for the complex phenomena connected with radio-activity without presuming that atoms are made up of corpuscles of the same or of different kinds. Now, the author suggests the hypothesis that these corpuscles once upon a time were free, constituting an extremely thin nebula; that subsequently they united around condensation nuclei, producing infinitely small suns which, by a process of further contraction, would take stable and definite forms, being the atoms of the elements known to us, comparable to small extinguished suns. The greater, not yet extinguished, suns would constitute the atoms of radio-active bodies.

This hypothesis would permit to explain (1) why radio-active bodies possess very high atomic weights; (2) why they give off energy, this being due to the contraction of their atoms.

Many anologies might, moreover, be pointed out between their behaviour and that of the sun, as, for instance, the luminous, calorific, actinic rays they give off, and the discharge of electrified bodies. As to the excited radio-activity, many observations go to show that air and freshly fallen rain and snow are radio-active; the author suggests that this radio-activity might be due to the action of solar light Moreover, it seems as though radio-active bodies should modify magnetic fields, just as it has been observed that terrestrial magnetism will vary under the influence of the sun. Nor is the fact that the activity of bodies subjected to very low temperatures is not destroyed an objection to the above theory, as the energy given off by the sun, surrounded by the cold sideral space, does not undergo any appreciable change either.

The fact that small quantities of radium are capable of giving off considerable amounts of energy may, finally, as well be easily accounted for. As, in fact, in spite of the powerful means of disaggregation at our disposal, we have not yet succeeded in separating the constitutive elements of atoms, the energy given off during their formation must, of necessity, be of an order of magnitude much superior to that observed in the case of contraction being due to gravitation, molecular, or atomic forces. As the atoms of radio-active bodies have not yet assumed their definite arrangement, being on the contrary in a state of formation, they must give off large amounts of energy.

Improved Powers of the Microscope.

A method enabling ultra-microscopical (*i.e.*, smaller than microscopical) *particles to be seen* has recently been devised by H. Siedentopf and R. Zsigmondy. In a paper published in the "Annalen der Physik," the authors draw attention to the fact that, provided the images produced need not be *conformous* to the original, it is possible to render particles of molecular dimensions visible to the eye. The condition to be satisfied is that the product of the specifical intensity by the surface of the luminous particles and the square of the sines of the effective luminous angle should be superior to the inferior limit of the sensitiveness of the eye. The particles to be seen are made luminous by means of an artificial illumination, such that the axis of the illuminating cone is at right angles to the diffraction cone of the particles. This process is somewhat analogous to the phenomenon observed when dust particles in a closed room become visible, as a beam of solar rays enters the dark room by a slot.

The authors think 36 $(\mu\mu)^2$ to be the inferior limit of the surfaces thus made visible. The molecules suspended in fluorescent bodies, as well as the particles of molecular dimensions contained in ruby glasses, will thus be observed by the eye. Their apparent size, it is true, will be many thousand times greater than their real size.

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Magnetic Properties of Alloys.

Both pure manganese and manganese copper are known to be quite non-magnetical. But Herr Fr. Heusler, in a paper read before the German Physical Society, Berlin, draws attention to the fact that very *strong magnetic properties* may be imparted to these substances by alloying with them certain other metals or metalloids. The most interesting behaviour of all the ferro-magnetic alloys, free from iron, thus obtained is shown by aluminium-copper-manganese. Heating to a temperature of about 110° will reduce this alloy to a state of stable equilibrium corresponding with a maximum susceptibility. The latter will increase for increasing percentages of aluminium, up to a maximum corresponding with a composition of equal atomic amounts of manganese and aluminium.

These results are the more interesting, as aqueous manganese salt solutions will exhibit a magnetic susceptibility somewhat higher than the corresponding ferric salts. The author, therefore, suggests comparing these aluminium-manganese bronzes with salt solutions where copper plays the part of solvent, the above combination of equal atomic amounts of manganese and aluminium having to be considered as dissolved salt. The transition points beyond which the alloys become non-magnetical are comparatively low, a rise being noted for increasing amounts of either manganese or aluminium.

Diffraction, as is known, consists in an apparent disturbance of the rectilinear propagation of light. These phenomena would seem to be paradoxical, as long as luminous beams were looked upon as made up of separate rectilinear rays, whereas they are a necessary consequence of the vibratory theory of light, they being produced whenever a portion of wave be intercepted by means of an interposed screen, when, at the edges of the geometrical shade, according to the nature of the light, either enlargements or alternatively bright and dark strips are observed.

Rontgen Rays and Light Rays.

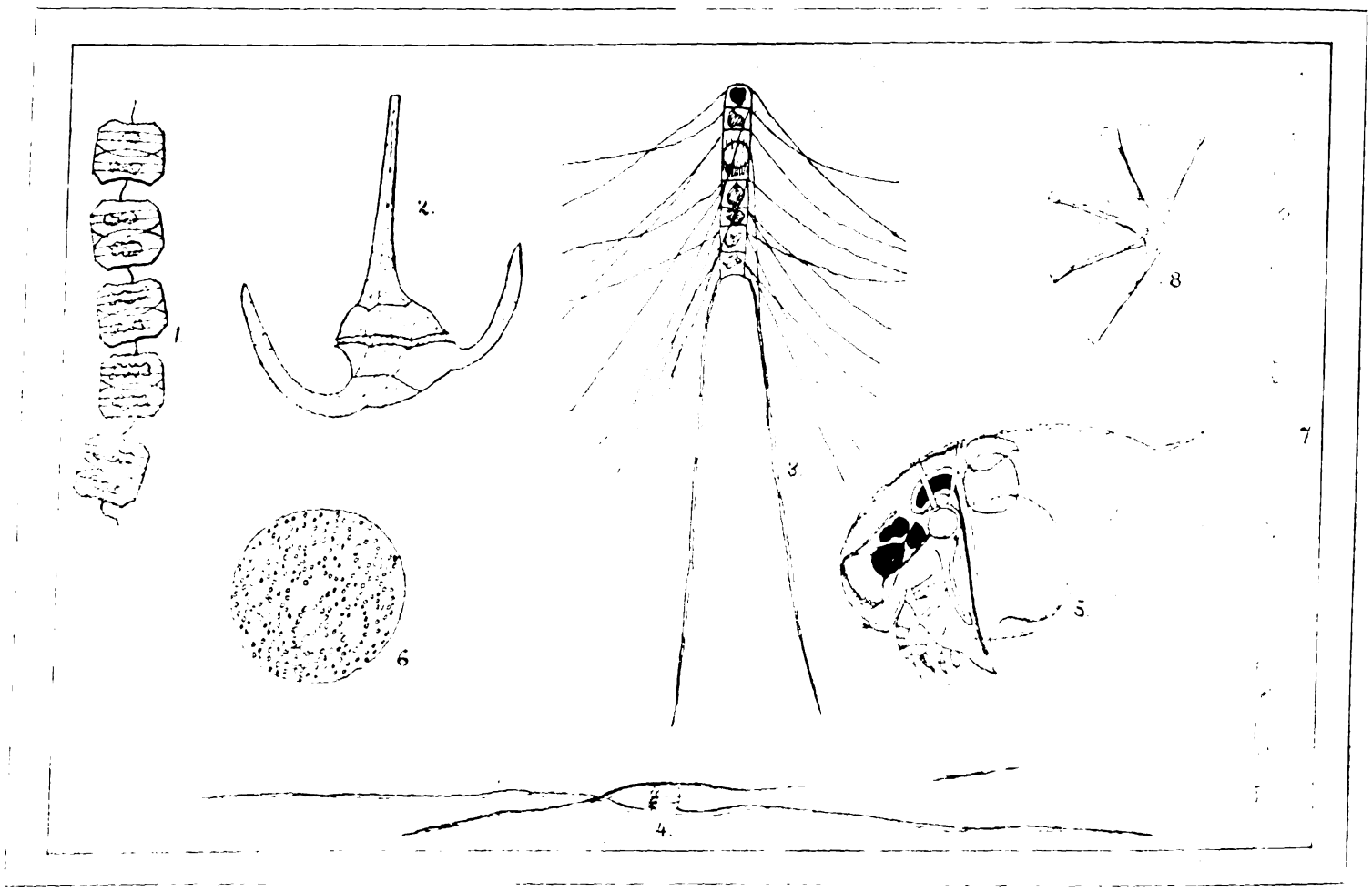
H. Haga and C. H. Wind communicated, as far back as 1899, to the Amsterdam Academy of Sciences, the results of some experiments, to the effect that *Rontgen rays* are *liable to be diffracted*. These results having lately been doubted by Dr. Walter, the authors repeated their experiments with an improved apparatus. This problem, in fact, offers an unusual interest, on account of the conclusions as to the nature of X rays that might be drawn from them. If, indeed, these rays are constituted by vibrations of the ether, they must, as luminous rays are, be liable to be diffracted. As the results of these repeated experiments go as well to show the existence of marked diffraction phenomena, the authors consider themselves warranted in maintaining that Rontgen rays are constituted in a way analogous to luminous rays.

Variations in Absolute Weight.

Prof. A. Heydweiller published some time ago an interesting note in the *Physikalische Zeitschrift*, to the effect that *radio-active bodies* will *undergo* most noticeable temporary *variations in their weight*.

Having introduced 5 gr. of strongly radio-active matter into a test-tube, the author compares its weight with that of a similar test-tube filled with glass fragments, of about the same weight and volume. Now, the striking result was found, that the active substance would lose about 0.02 mg. per day, this corresponding with a variation in the potential energy of gravitation equivalent to 1,2.10 F ergs. By means of a certain calculation indicated by Becquerel, on the hypothesis that radium rays are constituted by an emission of material particles, it is found that the loss of energy of this substance should be 10 F ergs per day, this being a striking agreement with theory.

These researches are, on the other hand, important in that they show the possibility of explaining by such radiation phenomena the variations in weight observed by Landolt and Heydweiller in connection with certain chemical and physical reactions. It is safe to state, however, that these results have been doubted by many; but as Prof. Heydweiller is engaged in pursuing his researches, it is to be hoped that this important question will be definitely solved ere long.



Plankton of the North Sea.

The Plankton of the North Sea.

By F. E. FRITSCH, Ph.D., B.Sc.

THE fact that the surface and the deeper strata of the ocean abound with myriads of microscopic organisms—both animal and vegetable—although familiar to most at the present day, was not so very long ago one of the still undiscovered secrets of Nature. True it is that in the latter half of the 18th century a number of forms became known, which were especially noticeable owing to their size, their peculiar characters, or their abundant occurrence, but it was Johannes Müller who in the forties of the last century first employed nets of fine gauze in the collection of pelagic organisms, and thus established a new line of research, which soon found many followers. Since the days of the *Challenger* expedition (1873-76) this branch of biological science has acquired a secure foundation, and much has already been done towards the solution of the many problems which it presents.

One of the first points to be discovered was the universal law that most of the littoral organisms of the temperate seas have a pelagic stage in the course of their development, which is not infrequently very different in appearance from the adult form. On board the *Challenger*, and in other marine expeditions undertaken about the same time, the universal presence of living organisms in the surface strata was conclusively proved. A large part of this living element is constituted by the numerous species of Diatoms—unicellular plants, assimilating the carbon dioxide of the atmosphere in the same way as the higher plants, *i.e.*, by means of a green pigment (chlorophyll), occurring in their cell-substance, but more or less obscured by a brown colouring-matter. Thus, the great masses of water on our globe have a vegetation of their own, and this, moreover, plays the same part as does the vegetation of the mainland; that is to say, the ultimate source

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of all the organic food-substance necessary for the numberless fish and other animals inhabiting the depths is to be found in the assimilatory activity of the myriads of little Diatoms. Since, however, light is a necessary factor in the conversion of inorganic to organic substance, these Diatoms are more or less confined to the surface layers; how, then, does the fauna of the sea-bottom and of the intermediate layers profit by their activity? Many years of observation have shown that the numerous pelagic animals (Copepods, Amphipods, etc.) serve as a connecting link between the surface and the depths. These organisms, to whom the Diatoms are the main source of nourishment, are continually changing their locality, and may occur at any depth between the surface and the sea-bottom, owing either to changes of temperature or to other unknown causes. These pelagic animals then constitute the food-supply of the inhabitants of the lower strata of the ocean, and thus act as transmitters of the organic substance, elaborated by the Diatoms at the surface.

Another point, which became clear at a relatively early date in the investigation of the Plankton, was the fact that at one and the same point the surface-organisms, occurring at different times of the year, may be entirely unlike one another. Two explanations of this periodicity of the Plankton-organisms have been put forward. According to the first, the changes in the constitution of the Plankton are due to biological factors—to temperature, light, etc.; whilst the second theory accounts for the periodicity in the perpetual motion of the aqueous strata, by means of which organisms from different regions are periodically introduced and again carried away, to be replaced by others. However much these two explanations may appear to differ at first sight, neither the one nor the other is in reality at fault, since both have recently been shown to apply. In every region a certain proportion of the Plankton is indigenous, developing afresh there year after year, whilst the remainder is derived from other regions and is introduced by the numerous currents, occurring in all parts of the waters of the globe. Just as a knowledge of the course of the currents at present assists us in explaining the variations in the constitution of the Plankton, a complete knowledge of the latter, such as is being slowly attained, will in future enable us to determine the existence of moving aqueous strata.

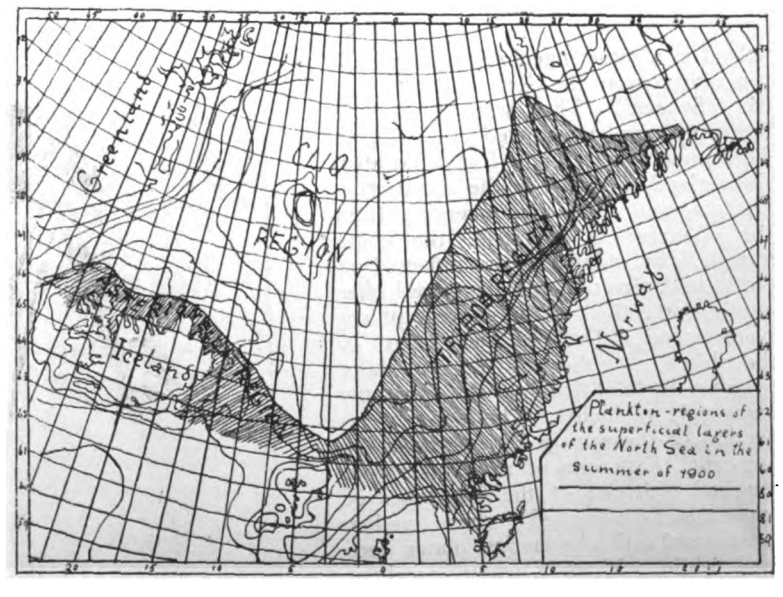
Looking upon the Plankton of the seas as a whole, all its manifold organisms may be divided into two great groups—the neritic and the oceanic. The neritic species are those which, in some way or other, are dependent on the bottom of the shallow littoral seas. They may, for instance, have resting-spores, which sink to the bottom and remain there for a certain period during each year until the conditions necessary for their germination prevail; if such resting-spores were formed in the open ocean the chances for their ultimate germination would be small and the young forms would be unable to attain the surface from the great depths of the oceanic sea-bottom. In correspondence with this we find that the true oceanic species form no such resting-stages. The neritic Plankton is further constituted by floating larvæ, the adult forms of which inhabit the sea-bottom (Echinoderms, Annelids, etc.), or the latter may form part of the Plankton, whilst the young stages are sedentary (Medusæ). All these forms are thus compelled to pass through part of their existence on the sea-bottom, and are thus, at some stage in their life-history, confined to the shallow coastal waters, where the distance between surface and bottom is not so great as in the open ocean. The oceanic species, on the other hand, are quite independent of the coast, and can continue their existence in the waters of the ocean through an unlimited number of generations.

The Plankton of the North Sea may further be classified in three great subdivisions according to the distribution of its constituent species towards north and south. One of these subdivisions (boreal or subarctic Plankton-element) is formed by those species whose centre of distribution lies in the North Sea itself, and which are rarer both to the north and south of this region. The species of this region are naturally those which are most characteristic of the Plankton of the North Sea. Two curious Diatoms (*Thalassiosira Nordenskiöldii*, forming long chains of cells, connected with one another by threads of mucilage, Fig. 1, and *Chaetoceras debile*, composed of long straight colonies of cells, each of which bears four long processes, Figs. 3 and 4) are the most abundant neritic species, whilst one of the curious motile Peridineæ, provided with an armament of plates and having two flagellæ, by means of which motion takes place, is the most abundant oceanic form (*Ceratium tripos*, Fig. 2).—A second of the three subdivisions is constituted by the arctic element, which mainly occurs in the cold north-western portion of the North Sea, whereas its species are wanting or sporadic in the warmer waters of the south-eastern region. The most important neritic form belonging to this subdivision is another species of *Chaetoceras* (*C. furcellatum*, *cf.* Figs. 3 and 4 of closely allied species), which does not occur further south, and is even very rare in the southern portion of the North Sea; of oceanic forms, *Ceratium arcticum* is most abundant. The chief zone of distribution of this and other arctic oceanic species is the polar seas and the cold superficial currents, emanating from them; however, they also abound in the cold aqueous strata, occupying the depths of the whole basin of the North Sea, and even extending further south beneath the warm Atlantic currents. Many of these species occur throughout the year in the deep Norwegian fiords, this being probably due to the uniformity of the temperature in these masses of water, which is, in reality, considerably above that in their actual zone of distribution.—The remaining one of the three subdivisions is made up of the temperate Atlantic element, the chief centre of distribution of the constituent species of which lies south of the North Sea, and which are restricted to the warmest southern portion of the latter. Amongst the neritic forms a species of the curious Diatom *Chaetoceras* (*C. didymum*) is again the commonest, but a little Crustacean, belonging to the *Cladocerae* (water-fleas), and known as *Evadne Nordmanni* (Fig. 5, a closely-related species), is equally abundant, whilst species of the genus *Ceratium* are again the most frequent of the oceanic forms. Side by side with these latter, however, a curious unicellular green Alga (*Halosphaera viridis*, Fig. 6) occurs abundantly, but is confined to those parts of the North Sea, traversed by the warm waters of the Gulf Stream. In the vegetative stage the cells of this Alga are relatively large and have a single parietal nucleus, but in March and April this latter commences to divide, and by the aggregation of little lumps of the protoplasm round each of the newly-formed nuclei numbers of little zoospores are formed, which serve to reproduce the individual. A very characteristic Diatom (*Rhizosolenia styliformis*, Fig. 7) is further commonly (especially in the summer and autumn) to be found in the southern portion of the North Sea; the much elongated cylindrical cells of this species are again united to form chains, as in so many Diatoms.

The facts discussed in the preceding lines are based on a consideration of the Plankton from the geographical point of view. The three subdivisions mentioned are, however, by no means sharply marked off from one another, and currents, moreover, tend to render their limits still more obscure. Thus it comes about that another classification of the Plankton is possible into Plankton-regions. In the North Sea we can distinguish three such regions (see the chart), characterised by a definite composition of the Plankton, which varies with the season of the year. The *Tripos*-region, occurring along the west coast of Norway, is essentially characterised by *Ceratium tripos* and *Halosphaera viridis*, which are both, for instance, entirely unrepresented in the *Asterionella*-region round about the coast of Iceland. This latter region owes its name to the abundant occurrence of a little Diatom (*Asterionella*, Fig. 8), which is accompanied by a species of the curious genus *Chaetoceras* (*C. cinctum*). The *Clio*-region, occurring in the north and west portion of the North Sea (*i.e.*, in all those parts which are not occupied by the two other regions), is mainly characterised by the presence of *Ceratium arcticum* and by a peculiar little Mollusc, *Clio borealis*, belonging to the group of the Pteropods. In addition to the few species mentioned in the preceding paragraphs, numerous others occur more or less abundantly in the North Sea Plankton, but it would go beyond the range of this article to enumerate them, and it must suffice to have indicated the most frequent and typical forms.

However, not only the surface-layers abound in these microscopic organisms; the deeper layers are also provided with them, although to a smaller extent, and the quantity of the Plankton may further differ appreciably in different strata. With regard to this latter point it may be remarked that in the North Sea the aqueous layers, which flow in from the Atlantic, are poorer in species and individuals than the deeper layers, which have an Arctic character. In general, two Plankton-regions are distinguishable in the depths of the North Sea—the first occupying the warmer strata of the North Atlantic current, the latter the icy cold layers at the bottom of the North Sea.

We have thus seen that in the waters of the ocean it is possible to more or less precisely mark off certain regions, which are characterised by the occurrence of definite associations of Plankton-species. Where marine currents emanate from the regions in question a certain amount of this Plankton will be carried off by them, and will serve to characterise them, and in this way the Plankton will be of great value in determining the limits of the currents in question. Moreover, Plankton investigations in many cases permit of the determination of the different constituents of waters, in which aqueous layers of varied origin are comingled. In hydrography, therefore, the investigation of the floating organic life will, in the future, most probably play a most important part.



Plankton of the North Sea.

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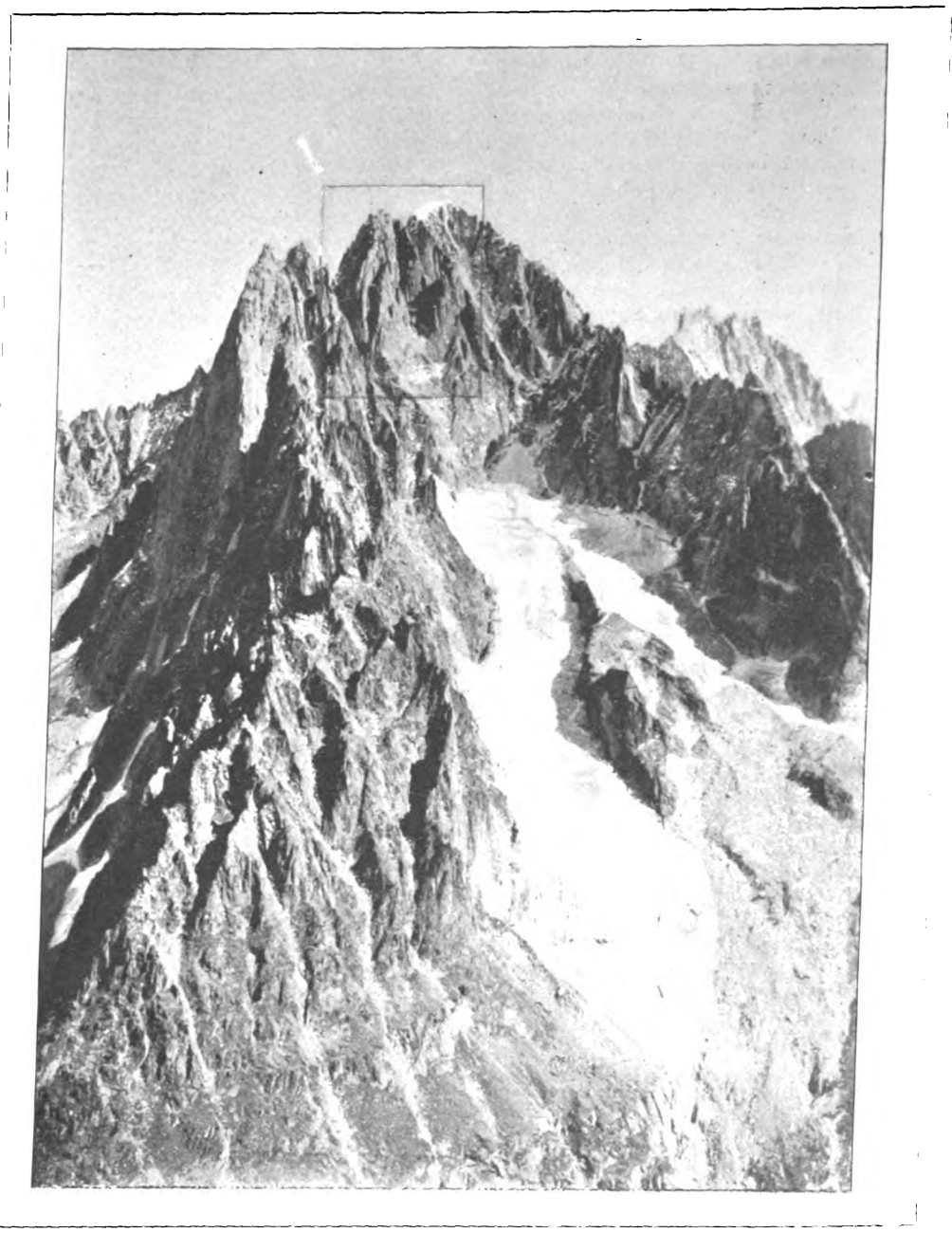
A Novel Telephotographic Apparatus.

A NEW apparatus has been constructed for photographing at great distances. This attachment consists mainly of a telescope, the objective of which has a focal distance as great as 2.40 m., the eyeglass being removed so that the image is formed at the focus of the objective. The only drawback Mr. A. Vautier-Dufour, the inventor of the apparatus, met with was the difficulty of carrying so cumbrous an apparatus about. This problem, however, has been solved in a most ingenious manner with the assistance of the Geneva astronomer, Mr. Scheer. The scheme of the apparatus, as constructed by Messrs. Boissonnas and Co., Ltd., Geneva, Switzerland, is shown in the accompanying diagram. The rays emerging from the objective A will strike the plane mirror B, by which they are reflected on the second mirror C, to be conveyed after another reflection, to the photographical plate placed at D. The focal length of the objective is thus broken into three sections, the total length of the apparatus being only $3\frac{1}{2}$ inches. The losses by reflection of the mirrors do not exceed 5 per cent. Exposures of 10 seconds were required with one of the first types of apparatus constructed when yellow screens and orthochromatical plates were used, while, without a screen, excellent snapshots could be taken with exposures of about 1-75 sec. The inventor has lately constructed an apparatus allowing of good instantaneous photographs being obtained with exposures ranging between 1-200 and 1-500 sec.

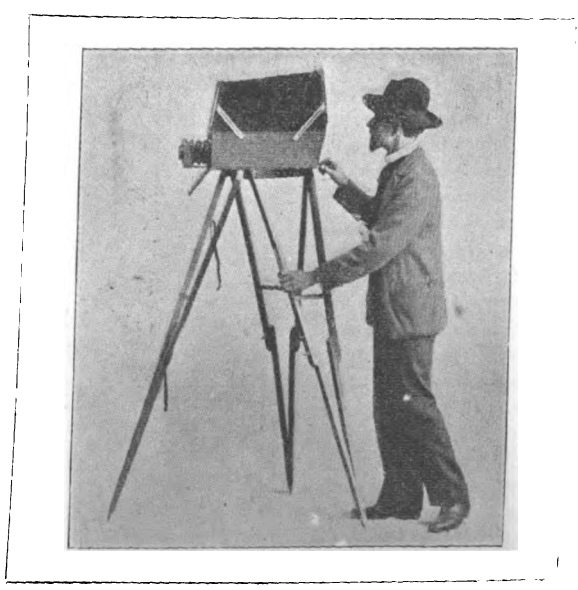
An additional advantage of the apparatus is the fact that it may as well be used to take ordinary photographs with an objective 0.25 m in focal distance, when the plate has to be placed in E. The "Téléphot," as the apparatus is called, may, moreover, be, at a moment's notice, converted into a terrestrial or astronomical telescope.

This ingenious device is remarkable for the intensity, good definition, and high magnification of the views taken with it, as well as for its easy adjustment. Telephotography in its new form is likely to prove useful both for scientific and industrial purposes, as well as in warfare. The physicist will be able to photograph any phenomenon visible at the extreme horizon, such as mirages, etc., as well as those which he could not himself approach without danger, such as, for instance, volcanic eruptions. The naturalist may now safely observe wild animals and photograph them from a distance. Astronomers will use the apparatus to take views of heavenly bodies. Explorers of remote regions will be in a position to observe, by means of the "Téléphot" distant and inaccessible points. Military and naval officers will be able to observe and to study the movements of the enemy, using the apparatus alternatively as a telescope and as a photographic attachment, and many other uses might be claimed for this ingenious apparatus.

A. G.



A New Method of Telephotography.
An ordinary Photograph of the Mountain Peak—The lines of the oblong shew the space subsequently Photographed by the New Method.



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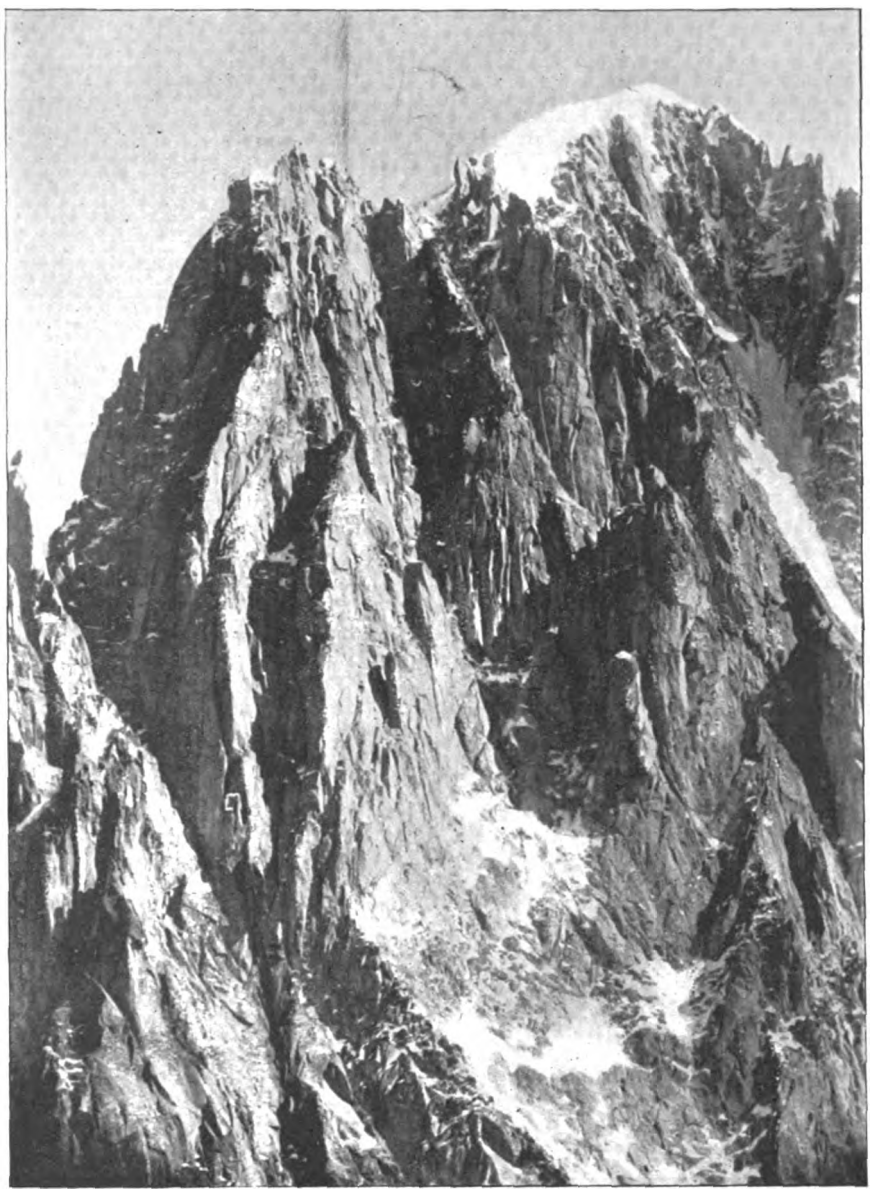
Fire Protection Engineering.

A Novel Departure.

THE question of fire prevention, which has engaged the attention of the delegates to the International Fire Protection Congress, will doubtless bear fruit in the extension of methods at present in force for combating the ravages of fire, and it may be hoped that another result will be seen in the more prompt recognition and application of new mechanical appliances wherever these are shown to be effective agencies of control.

There is, however, one aspect of the fire problem which has hitherto received but scant notice, namely, fire protection engineering as a distinct technological study, conducted on lines similar to those supplied by up-to-date mechanical, electrical, and chemical engineering courses. The organization of a school of instruction of this important character is about to be undertaken by the Armour Institute of Technology of Chicago, a college and academy which has now had some twenty years' useful existence, and owes its foundation primarily to the munificent benefactions of Mr. Philip D. Armour, a Chicago merchant. The institution, by the way, is one designed for students seeking a practical education, while it particularly encourages those who realise the value of self-reliance as a factor in the pursuit and development of their studies.

In response to requests from insurance companies, architects, and contractors, and to meet a recognised want, a four years' course in fire protection engineering, leading to the degree of Bachelor of Science, will be inaugurated next month at the opening of the academical year. The requirements for the admission of students are to be made identical with those for the mechanical, civil, and chemical engineering courses, in order that a creditable standard may be set by freshmen. In the first instance the technical laboratory work of the new department will be carried on at the Underwriters' Laboratories, Chicago. These are maintained by the stock fire insurance companies, and are peculiarly well adapted for the purpose, since novel devices, appliances, and materials that enter into the question of fire protection, or have a bearing on the fire hazard, are taken there to be tested. A special feature of the training at the Armour Institute will be a series of lectures by prominent insurance officials and other experts upon the practical side of their profession. The field in the direction indicated is an open one, and the initiation of the school and its subsequent career cannot fail to be watched with interest by all concerned in the intricate ramifications of fire and insurance matters.



A New Method of Telephotography.
This Record Photograph shows the Peak enclosed in the oblong of the first Photograph.

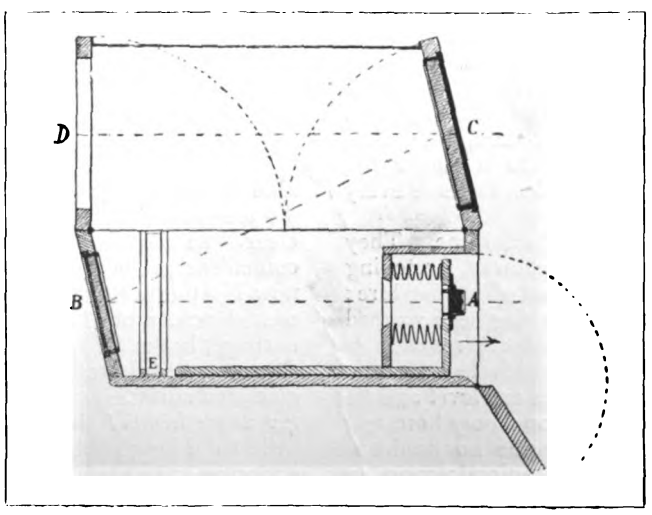


Diagram of the Apparatus.

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A Pebble of Blue Lias.

By the Rev. W. TUCKWELL, M.A.

"Il fouille une parcelle de gypse, y aperçoit une empreinte, et vous crie 'Voyez!' Soudain les marbres s'animalisent, la mort se vivifie, le monde se déroule!"—BALZAC.

FOR a sermon in stones the fitting pulpit is a stonequarry; its bible lying open, its texts, as in Gray's churchyard, strewn around. Let us transport ourselves into a "pit" of Warwickshire Lias, and stand amid its shattered refuse. In front of us is the raw, freshly-cut cliff, rising eighty feet, and extending right and left for a quarter of a mile, in striped ribbon-like *layers*, whence possibly is derived its name. These are alternately dark blue and grey; the grey are of hard rock about a foot in thickness, and between them are wider bands of soft blue finely laminated clay. The rock alone is commercially valuable; this is hewn or blasted by the quarrymen, tumbled in masses to the bottom, and carried off in trollies to the mill; the clay is wheeled across temporary bridges to fill up the excavation from behind. With three years' cultivation it will become serviceable wheat land. The frugal owner lets it for so long to his labourers in allotments; then, when their toil has "fettled" it, turns them out, and takes possession. *Sic itur ad inferos.*

But the text comes before the sermon. "What is your text?" says Olivia to the Duke's messenger. It is a piece of hard blue stone, in size and shape like a man's hand, not quite two inches thick. One side is smoothed, but traversed by slight grooves or scratches; the other side is glazed, and shows a pattern of polygonal cracks filled up with silica or flint. The whole history of the quarry, its

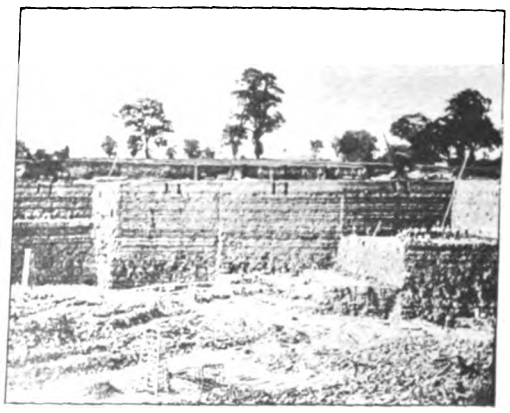
Boulder of Mount Sorel Granite from the Lias Boulder Clay.

Æonian genesis and mutations, its subsidence and resurrection, its superficial clawing by Time's five great fingers in comparatively recent days, are written on this little stone.

Let us trace it to its source; analyse, that is, a fragment of the quarry rock. We find that one-fifth of it is mineral; silica and alumina mostly, with a very little iron; two-fifths are lime, and two-fifths carbon. Now lime in the earth is traceable to animal life, carbon to vegetable life; so that four-fifths of the grey rock was once animal or vegetable. The blue clay is rather different; only three fifths of it are lime and carbon; two-fifths are mineral, the silica largely preponderating; yet in this, too, more than one half is of animal or vegetable origin. Accordingly, as we crack the rocks or rummage in the clay, we find both swarming with fossil remains; here are leaves and boughs of conifers, sometimes crystallized into jet, finely marked bark of trees, cycads, giant mares' tails, beautifully veined ferns. Here, too, is a whole stone menagerie of animals: sea lizards without end we find, in fragments mostly of bony vertebræ and paddles, though ten years ago I described in *Nature* a monster twenty feet in length disinterred complete from this particular quarry. With them are lovely star fish, sea-urchins, feather-stars, ammonites ranging in dimension from a small cart wheel to a finger tip, remains of crocodiles and fishes, worms, crabs, cuttles, shells of every marking, size, and shape.

Observe that nine-tenths of these remains are maritime. They tell of a deep and quiet sea with shallow muddy shores, stretching from what is now the mouth of the Tees to the coast of Dorsetshire; the terrestrial plants, insects, and land animals having been washed or blown into the water from the older Triassic shore, remains of which crop up close by. It was a tranquil sea, on which sleek Panope with all her sisters might have played, for the beds are level and lie in thin plates showing gradual and gentle deposition; only here and there is evidence of a rush from some great river, due no doubt to heavy rains, which slew and buried the unwary animals sporting near the shore. A part of one such victim lies before me as I write, the stomach of a huge scaly Saurian distended with a mass of fish bones. "Muddy death," which vanquished poor Ophelia, smote him, we know not how, his dinner freshly swallowed. With enlarged outline and unbuttoned waistcoat, like an alderman after a City banquet, he has lain during a million ages, and now figures in my cabinet, his dinner still protruding from his stony stomach, the constituents of his gluttonous meal as undigested and as evident as on the day when it was devoured.

So during more centuries than we can count he and his brethren continued to live and die, sinking to the bottom after death, and sealed up in the soft ever settling sediment, until by a wrinkle in the



Face of a Lias Quarry.

earth's cooling crust the whole sea bed subsided; until the pressure of water from above, of fiery matter from below, slowly condensed and baked the mud with all its denizens into rock. Homogeneous when it was depressed, it underwent in the depths a chemical reaction. The mineral particles segregated from the mass, arranging themselves in separate bands and displacing the organic compounds; accomplishing by degrees the severance into parallel layers, one with an excess of silica, iron, and magnesia, the other with an excess of lime and carbon. Another million æons, and the whole mass rose up again into air, to be washed down by rains, carved into valleys and plains by rivers, to take on its surface soil and grass and trees, to reveal to the quarryman of to-day the facts of its long-buried past.

But something more was to befall it first: between its resurrection from the bowels of the earth and its excavation by the labourer's pick it was to suffer another change; and that, too, is graven on the surface of this little stone. I said that its smooth under-surface was slightly scratched and grooved. These scratches are not recent; it bore them when I dug it from the stiff boulder clay which in places overlies the rock; and along with it I found at various times lumps ranging from the size of a cricket ball to masses of more than a ton in weight, composed of Mount Sorrel granite, Charnwood Forest syenite, mountain limestone, decomposed red sandstone; all trace-

Lias Reptiles at Home.

able to sources sixty miles away, all finely smoothed and scratched. To the geologist these intruding foreigners drop sense distinct and clear. In days which to him are not so very long ago, days coincident probably with the advent of earliest Man into what is now Northern Europe, an icesheet four thousand feet in thickness passed across our land, ground away its coating of soft earth and herbage, broke off and tossed about its rocks. Melting finally into deluge under altered cosmic influences, it left behind it planed and glaciated surfaces, scratched stones, erratic blocks, and boulder clay. *Ex ungue leonem!* the whole strange romance is epitomised in my little hand-long pebble. Portion once of a Lias shore; cracked by exposure at low tide, as beaches crack to-day, into angular fissures later filled with infiltrating silica; hardened in the abyss; ascending into air; torn from its place by the ice, rounded, smoothed, and

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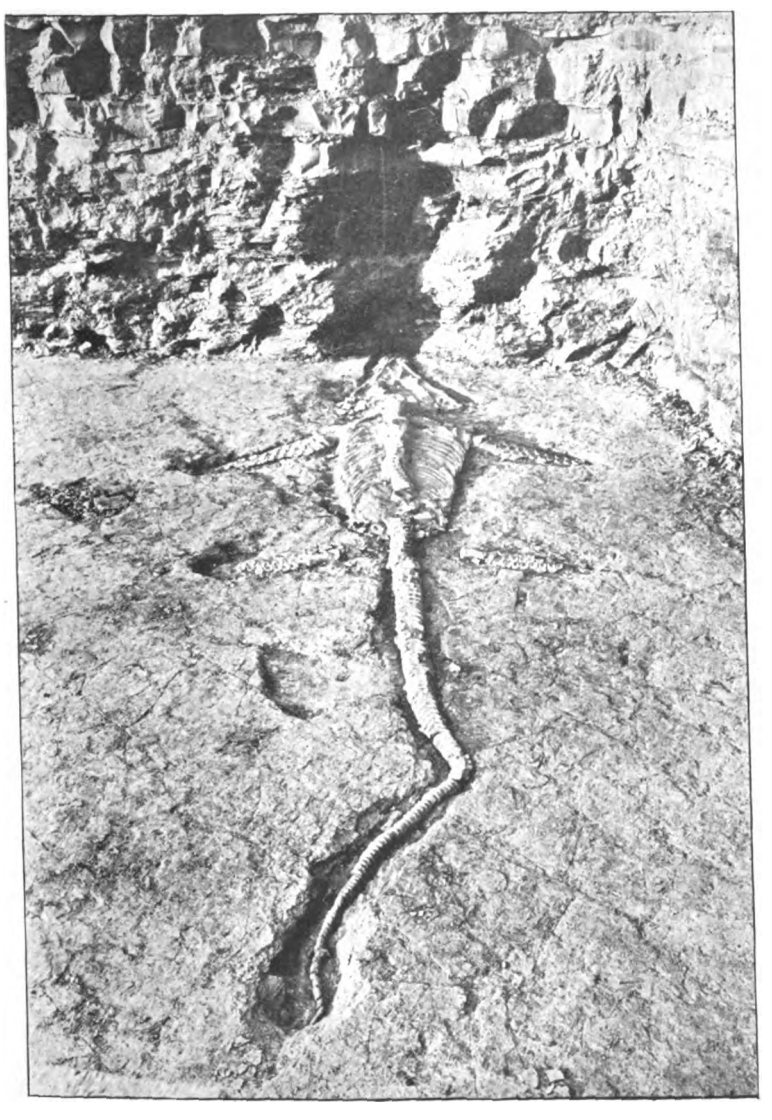
scratched ere it settled into the thawing mud; wearing still upon its surface the stamp of its early gradual construction and the scars of its later rude dislodgement; it comes like the stone set up by Joshua at Shechem to witness that which it has seen and known of epochs parted from one another, it may be by a million, it may be by a score of million years.

* * * * * * *

Lias Plants.

Early in the last century it was discovered that certain limestones, when burned and reduced to powder, would "set" under water to the consistency and durability of the hardest rock. This substance was called "hydraulic mortar"; subsequently, from its resemblance in colour to Portland stone, came to be known as "Portland cement." Of these limestones the most plastic and most



Fossil Skeleton of Ichthyosaurus.

accessible are found in the Lias beds; and so the early quiet secular changes through which our quarry was evolved in Nature's plea are supplemented now by transformations ruder and more abrupt at the hand of man. Let us follow our truckloads of stone as they roll self-impelled down a railed incline to the cement works. The iron jaws of a crusher break them into gravel; that is ground down and mixed with water; the paste is dried into cakes and burned in an intensely hot kiln; the fused lumps are powdered into dust between hard quartzite millstones; the resulting powder, packed in bags or boxes, goes all over the world as Portland cement. A week of white heat in the kiln has worked on the calcined mass chemical changes which in Nature's leisurely handiwork demanded centuries. The carbonic acid and the water are driven off, the lime is slightly increased, the silica and alumina more than doubled; the magnesia and iron, only just perceptible in the rock, are quadrupled in the cement; the whole mass is metamorphosed in the burning fiery furnace as Wordsworth's mountains seemed to him to melt in the crucible of a setting sun.

A sermon, preachers tell us, is imperfect without an "application." Mine shall be very brief; it shall be a glorification of "common objects." The incisions on a Tell El Amarna tablet are not more eloquent to a Petrie or a Winckler than are the roadside pebbles, the tide-washed refuse, the exuviæ of chalk pit, stone quarry, coal mine, to the adept in Nature's laboratory. The one was scratched by a cuneiform scribe; the others, like the law-stones of Hammurabi or of Moses, are written with the finger of God; yet for a single man or woman that pauses to mark and learn these last, a multitude pass by regardless. But the difference between Eyes and No Eyes is a difference of instruction, not of Nature, and the trend of education to-day is towards Nature-notes and observation-lectures. "Both these I serve and of their train am I," as Milton says: under their shelter I emit my little sermon; a stimulus, I would hope, to those who have passed unopened hitherto the pages of the Great Stone Book; to experts a familiar tribute from a veteran brother of the hammer, who was chipping out Montlivalvias and pocketing Selenites in the Oxford Coralline Oolite, perhaps before many of them were born.

Heads and Horns of the Insect World.

By Percy Collins.

The trophies of the entomologist's wanderings are often exceedingly minute. They are always small, compared with those which fall to the lot of the big game hunter. Yet he also possesses his heads and horns, and they rank amongst the most weird and grotesque that the world can show. Indeed, their appearance recalls the terrifying creatures of antediluvian epochs.

Take, for instance, the Hercules beetle of tropical South America. It is a giant of its kind, for a fine male will measure as much as six

inches in extreme length. Rising from the summit of its thorax, or chest, is a curved horn, in length very nearly half that of the whole beetle. A shorter horn is mounted upon the head, and both are somewhat notched and toothed, while the larger one is clothed with a copious growth of soft hairs—like the pile of velvet—upon its under surface.

Such remarkable horns as these would seem to exist for some very definite purpose, and the observer is at once led to enquire what this may be. To what use does the Hercules beetle put its fine horns? Unfortunately, no one seems able to answer the question at all satisfactorily. It is at once the strangest and the most tantalising fact in

connection with insect horns that their use is, in most instances, a hopeless mystery. Of course, some more or less plausible theories have been advanced. In many cases it is the male insect which alone possesses these huge appendages, and this seems to lend colour to the suggestion that they may be useful as weapons of war. The beetles may fight with their horns, just as stags and bulls are known to do. There appears, however, to be very little evidence to bear out this theory. It is doubtful whether the beetles have ever been caught in the act of fighting, while their horns are invariably smooth and polished—without any scratches, such as might be looked for after rough or constant usage.

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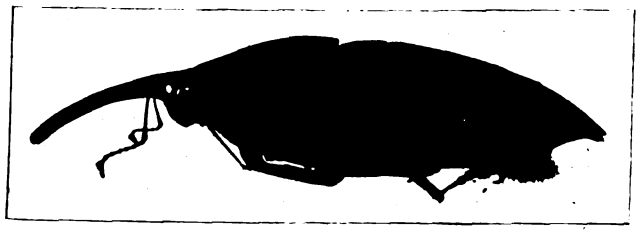
That the horns may, in some cases, be used for wounding fruit or leaves, upon the juices of which the beetles may feed, seems a possible explanation for their existence. At the same time, it must be borne in mind that while one or more horns are immovably attached to the thorax, the opposing horn or horns are fixed to the head. Thus, to make use of them as nippers, the beetle would have to move its whole head upwards and downwards. So that the horns would seem to be



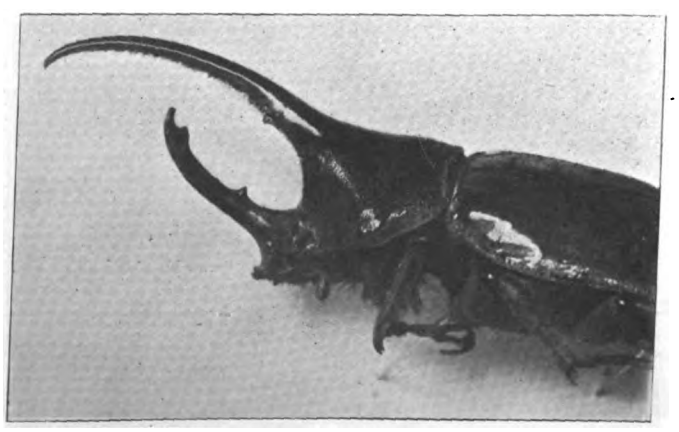
clumsy tools, at best, especially as their respective positions are often such that it would be impossible for them to be brought into anything like close contact.

Perhaps no utilitarian explanation for these horns exists. They may be merely incidental to excessive vitality. In Nature the male sex not infrequently possesses certain outgrowths, absent in the female,

which are apparently superfluous. The beard of a man is a sufficient and familiar example. In the language of science, "the small and active sperm-cell with a more abundant vitality than the passive egg-cell, dissipates energy, while the egg-cell stores it up." So that it is not impossible that these beetle horns may represent the superfluous energy of their possessors. The fact that in the same species the

horns vary enormously in size and development seems to strengthen the theory—for small, underfed insects might be expected to produce smaller horns than those which had enjoyed the advantages of abundant food and moisture.

There are, of course, some horns which cannot be explained in this way. A case in point is the big *Phanacus*, or Dung Beetle, of



Brazil. Both the males and the females of this insect have long spines or horns on the summit of the head; and these show such a uniform development, and are placed in such a position—directly in front of a deep cavity in the creature's thorax—that they almost certainly exist for some definite purpose. The insect's habits are exceedingly remarkable. It spends its time in forming immense balls of dung, as large as itself, in the centre of which it places an egg. These balls are rolled about by the beetles until the exterior is baked quite hard in the sunshine. The interior is thus kept in a moist condition, suitable for the food of the grub which ultimately hatches from the egg. It is, therefore, conceivable that the *Phanacus* makes use of its horn and the cavity in its thorax to collect and carry dung to the spot on which it is making its ball.

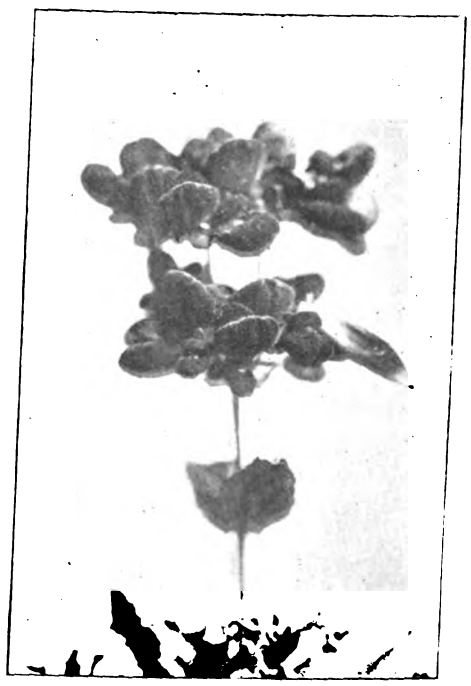
There is a great group of beetles, comprising many hundreds of tropical species, known as "Longhorns," on account of the abnormal length of their feelers. The grubs of these beetles all feed upon decaying wood. They are, in fact, the scavengers of the tropical forests. Many of them are so large that their labours are sufficient to reduce a vast trunk of timber to powder in the course of a few weeks; and in this manner they literally prevent the forest from becoming choked by its own decay. The parent beetles of these grubs often possess feelers lengthened out of all proportion to their bodies. To look at them, one would imagine these appendages to be most unwieldly and burdensome. It is probable, however, that the beetles require them for searching the crannies in the wood—perhaps when questing for suitable holes into which they may drop their eggs.

One of these Longhorns has not only its feelers, but also its front legs lengthened out in this extraordinary manner. The insect is native to Brazil and other tropical American countries, and passes its time in sluggish perambulations on the rough bark of trees. Its grotesque fore legs may be useful to it when burrowing into rotten wood, or forcing its way beneath loose bark.

A Curious Botanical Monstrosity.

By GRAHAM BOTT, F.L.S.

THE accompanying photograph shows an interesting freak of one of the flowers of a calceolaria grown in the garden. This interesting modification has occurred once previously in plants cultivated by the writer. It is interesting because, when these teratological specimens occur, it is the central or terminal flower which becomes modified, and which Darwin maintained was always the case. But the present instance demonstrates that that is not invariably so, for, by reference to the illustration, it will be seen that the exceptional form occurs laterally. It will be noticed that the petals, instead of forming the



usual slipper-shaped (calceolate) flower, have assumed the form of a tube about 3.5 cm. long somewhat swollen in the middle and tapering towards each end. It is of the usual yellow colour, but the free end is covered by, or terminates in, a small greenish band, and in the centre is a slit-like opening. The petals, normally unequal in growth—two regular and three irregular—have become equal and united along its whole length, thus a regular, instead of, as is usual, an irregular, corolla has been produced. The flower is neuter, exhibiting neither stamens nor pistil. How these peculiar variations originate is not definitely known, but the writer is of the opinion that excess or degradation of one or more of the constituents of the soil together with enrivonment is the chief, if not the factor, in determining floral freaks. It may be added that the great Swedish naturalist, Linnæus, termed such a modification of structure *Peloria*, that is, a flower which takes on a regular form, although normally irregular. Readers may be aware of other instances which occasionally appear amongst wild flowers, a familiar example being that of the yellow toadflax (*Linaria vulgaris*, Mill. N. O. *Scrophulariaceæ* which, as a rule, produces only one spur, but will, on rare occasions, develop five spurs, thus making it regular.

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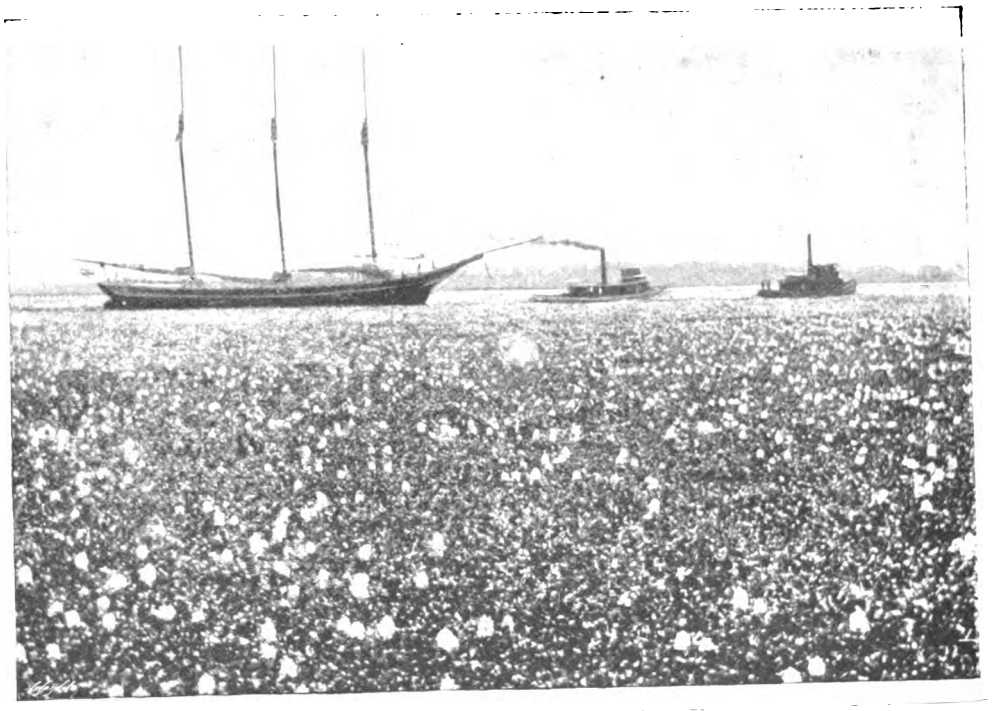
Destroying a Sudd.

The Water Hyacinth in the St. John's.

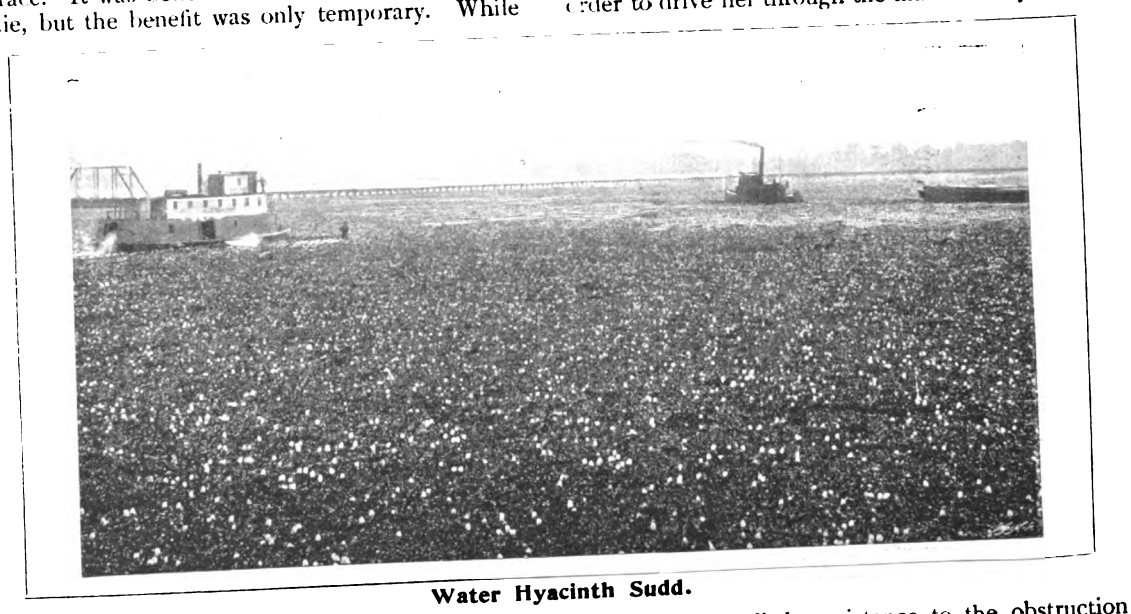
In an article in the *Illustrated Scientific News* on "sudds," or river-blocking growths of vegetation, which occur on the Nile, the Ganges, and some rivers in America, reference was made to the curious case of the water hyacinth, which, originally introduced into the United States as an ornamental plant, has developed to such an extent in some rivers and creeks as to prove a serious obstacle to navigation. Many efforts have been made to cope with the pest; and, according to the *Scientific American*, experiments have been made during the last year by the United States Government with the idea of ridding the southern waterways of the hyacinth. As is well known, the variety called the water hyacinth spreads so rapidly and has such a rank growth, in Florida and Louisiana, that it has seriously interfered with navigation and in some cases has completely blocked streams which had hitherto been available for the use of light-draft steamers.



A Ship being towed through a growth of Water Hyacinth.

The hyacinth has been especially troublesome on the St. John's River, where various schemes have been tried to destroy it. One of the plans was to equip a steamboat with a propeller provided with blades having very sharp edges, with the view of cutting away the growth below the surface. It was believed that this treatment would cause the plants to die, but the benefit was only temporary. While lanes of open water were made by the action of the rapidly moving propeller, they were soon filled with the hyacinth, and this scheme was abandoned. At some of the smaller wharves on the St. John's, the growth has been so thick that it has been necessary to go out in boats and cut away with sickle and knife a large area, in order to allow a vessel to moor at the dock, while some of the smaller wharves have been abandoned, as the plant grows so thickly about them that a boat driven by quite powerful engines is in danger of becoming blocked in the midst of a bed, unable to extricate itself.

The method which is now being tried, however, seems to have solved the problem of how to destroy the hyacinth, and it is believed that if sufficient equipment is provided eventually all of the southern water courses may be cleared of the pest permanently. A chemical has been compounded which has such an effect upon the plant that if it comes in contact with the stem or blossom these portions soon wither; but the solution is so powerful that it works its way down the stem, killing the root as well. Some of the ingredients of the chemical are known only to the inventor, but a large quantity of acid is used in its preparation. The process of manufacture is very simple, the "laboratory" being placed upon a barge provided with two tanks each of which has a capacity of 5,000 gallons. Connected with the tanks is a boiler in which the ingredients are mixed at a high temperature produced by steam heat. The barge is of such light draft that it can be towed by the spraying boat if desired, but the latter is provided with three reservoirs each holding 3,500 gallons, which are filled by pumping from the barge. Pipes lead from the reservoirs to a steam pump which supplies the spraying apparatus. This consists of three booms. One extends directly in front of the vessel, being supported by a block and tackle attached to the bow deck. The others project from the sides of the vessel. The sprayers consist of hollow tubes which are perforated at intervals of about a foot and the holes fitted with miniature nozzles. The liquid is forced into the sprayers through lines of hose which are connected to the sprayers by couplings in the usual manner. The arrangement of the sprayers is such that the chemical can be distributed over a space 90 feet in width when the boat is moving. The boat containing the spraying apparatus is of the type of craft used on southern rivers, drawing but 4 or 5 feet of water. She is provided with very powerful engines in proportion to her size in order to drive her through the masses of hyacinths, and is so modelled as to offer as little resistance to the obstruction as possible. Her reservoirs carry a sufficient supply of chemical to cover about 100,000 square yards, and on a portion of the stream where the growth is not too rank the steamer will treat this area of surface in a day. In places where the side sprayers cannot be used on account of trees, etc., the chemical is applied through a hose by the crew.



Water Hyacinth Sudd.

Such is the destructiveness of the solution that within a few hours after its application the withering process begins, and microscopic tests prove that the liquid penetrates the growth below the water, killing the roots. Portions of the dead growth which have been pulled up from the bottom of the St. John's River show that the chemical rots the fibre and disintegrates it to such an extent that it no longer hinders navigation. The seeds are destroyed as well as the plant, and efforts are made to cover as much space as possible during the seeding period.

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Magnetic Detectors in Space Telegraphy.

BY ERNEST WILSON,
Professor of Electrical Engineering, King's College, London.

SUPPOSE that a ring of magnetic material is uniformly wound with a magnetising coil through which an electric current is gradually varied between equal positive and negative limits. The magnetism of the ring (after the process has become cyclical) will also vary in intensity between equal positive and negative limits. The curves in Fig. 1 show how the intensity of magnetism at fairly low limits varies with the magnetising force in the case of hard steel (curve 1) and iron wire (curve 2)—the magnetising current being plotted horizontally, and the intensity of magnetism vertically, about the origin o. It will be seen that each curve rises rapidly as the magnetising current is being increased near its positive or negative

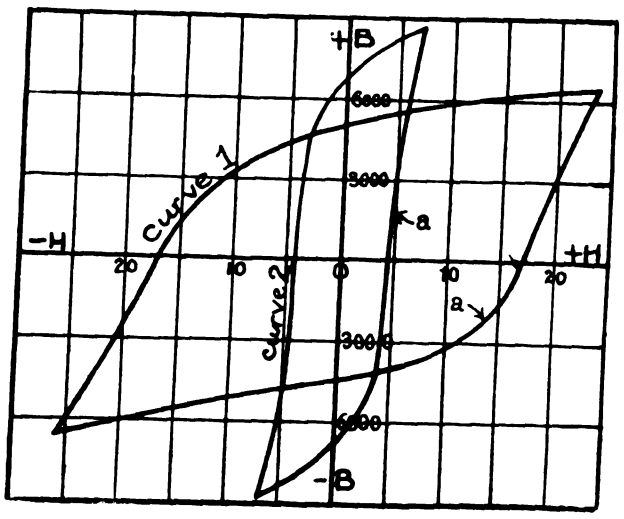

Fig. 1.

limits, that when the current is reduced to zero value the rings are still magnetised, and that in order to reduce the magnetism to zero value a reversed current is required. It is well known that if iron is taken through a magnetic cycle, as in Fig. 1, it is extremely sensitive to vibration or change in the magnetising force when on the steep part of the curve; for instance, at the point *a*. Professor Ewing remarked on this some years ago,* and I found it so marked in a specimen of very pure iron that I made it the subject of research.† Indeed, it was this research which led up to a good deal of my work on magnetic detectors. If, for instance, the magnetising force in Fig. 1 be varied until the point *a* is reached in either specimen, and be then kept constant, a tap will cause a considerable deflection with a Ballistic Galvanometer placed in a secondary circuit linked with the specimen. But without tapping the specimen the magnetism may in some cases go on changing in the direction of acquirement for some seconds after the magnetising

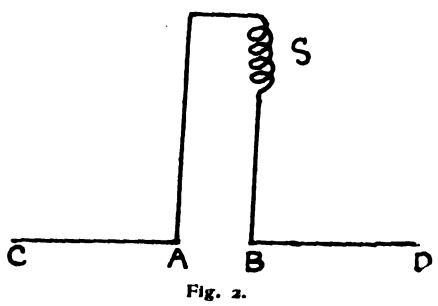

Fig. 2.

force has ceased to vary. As will be shown later, electric impulses transmitted from a distance are capable of producing analogous effects. If a few wires of magnetic material are wound with a coil of insulated wire so placed that it can receive electric impulses produced by well-known processes in space telegraphy, it is found by experiment that a variation in the magnetising force is exerted. For instance, suppose that the wires have been previously magnetised either by passing an electric current through the coil for a short time, or by placing the wires between the poles of a magnet. The wires, as shown above, retain their magnetism to some extent, although the magnetising force due to the current (not the free ends of the wires, if any) has been removed. On the application of the electric impulses received from a distance by the coil on the wires, their magnetism is varied, as can be shown by a delicately suspended magnet in the neighbourhood being deflected, or by an audible sound being produced in a telephone connected to the coil on the wires.

It is not necessary to describe the experiments of Professor Henry and others, in which steel needles were placed in receiving or secondary circuits with a view to determining the direction of the currents induced

* Royal Society Proceedings, Vol. 46, p. 269.
† Royal Society Proceedings, Vol. 62, p. 369.

in those circuits when an oscillatory discharge was passed through a neighbouring or transmitting circuit. So far as I am aware the first person to publish an account of the employment of magnetised wires for the purpose of detecting electric impulses for signalling was Professor E. Rutherford, F.R.S.* His detector can be best described in his own words, and is shown diagrammatically in Fig. 2. "About twenty pieces of fine steel wire .007 cm. in diameter, each about 1 cm.

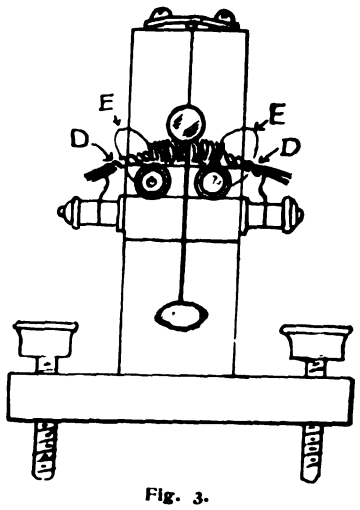

Fig. 3.

long, and insulated from each other by shellac varnish, formed the detector needle. A fine wire solenoid was wound directly over it of two layers corresponding to about 80 turns per cm. As the solenoid was of very small diameter, about 15 cms. of wire served to wind the coil. This small detector was fixed at the end of a glass tube, which was itself fixed on to a wooden base, the terminals of the detector coil being brought out to mercury cups. S, Fig. 2, represents the

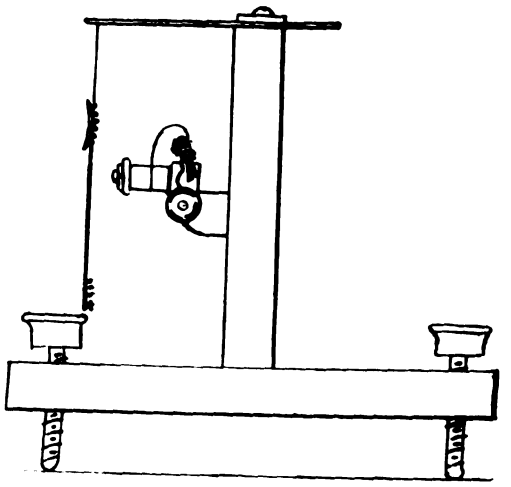

Fig. 4.

detector needle and the solenoid wound over it. A and B are mercury cups. CA and BD were two straight rods, which served as receivers, one end of each being placed in the mercury cups. The detector needle was strongly magnetised and placed before a small magnetometer, the deflection due to the needle being compensated by an auxiliary magnet. If the receiving wires were parallel to the electric force of the wave from the vibrator, oscillations were set up in the

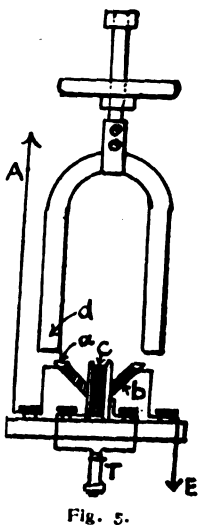

Fig. 5.

receiver circuit, the surface layers of the needles were demagnetised, and there resulted a corresponding deflection of the magnetometer needle." "When the vibrator was set up in the top floor of the Cavendish Laboratory, a small but quite marked effect was obtained at Park Parade, a distance of over half a mile in the direct line."

In 1897 the author of this paper commenced experiments at King's College, London, with Mr. S. Woodfield, then with

* Royal Society Proceedings, 1896, Vol. 60, p. 184. Phil. Trans. A, 1897, Vol. 189, p. 1.

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Mr. C. J. Evans, and has continued them from time to time. As a reference will be made to these experiments later I will only refer to a piece of apparatus described at the time.* It is shown in Figs. 3 and 4, and consists of a frame which supports a few fine iron wires insulated from one another and wound with two coils of insulated copper wire, D and E, connected to terminals as shown. In front of this little electro-magnet is suspended an ordinary astatic galvanometer system of mirror and magnets. The arrangement was placed in front of a scale on which a spot of light reflected from the mirror could be seen and its movements observed. A permanent

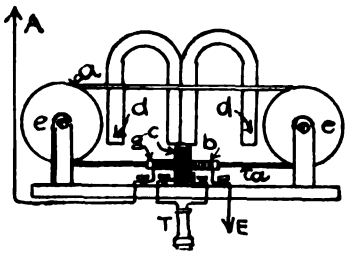

Fig 6.

magnet (not shown) was used to control the suspended system. One object I had in view was to be able to apply a local magnetising force to the magnetic detector without moving it as in Rutherford's experiments. One of the coils of the detector was connected to a local battery through a key, and the other to the receiver of Hertzian waves. It was then only necessary to close the local battery circuit in order to magnetise the wires. This deflected the suspended needle. The Hertzian waves produced an effect which demagnetised the bundle of wires, and deflected the mirror in an opposite direction. In this manner observations were made of the arrival of electric impulses

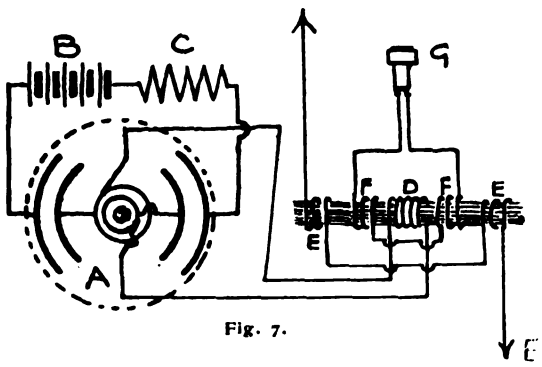

Fig. 7.

from a distance. In the patent is described an arrangement whereby the needle closes the local battery circuit with a view to automatically magnetising the wires ready for the next signal, and causing a current to pass which can operate a Morse Inker or other mechanism.

In 1902 Mr. G. Marconi described two forms of magnetic detectors,† which are illustrated in Figs. 5 and 6. In Fig. 5 a bundle of fine iron wires *a* is placed opposite the poles of a permanent magnet *d* capable of rotation about its vertical axis. The fine wires are wound with an insulated conductor *b*, which receives the electric impulses from, say, an elevated conductor, A. Another coil *c* surrounds the

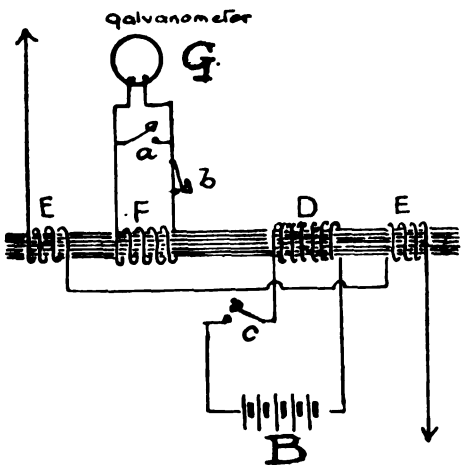

Fig. 8.

fine wires, and is connected to a telephone, T. Sounds are produced in the telephone, T, in keeping with the arrival of the electric impulses, which, as above stated, produce a magnetising force and disturb the magnetism of the iron wires, thereby inducing electric currents in the telephone. The permanent magnet is rotated so as to vary the magnetism of the fine iron wires, and the effects are more pronounced in the telephone when the magnetism is most unstable. We here have the employment of a rotating magnet to produce the variation instead of a magnetising force, due to a varying electric current in a magnetising coil on the wires. In Fig. 6 a second arrangement is

British Specification, 30846, 1897; also "The Electrician," 12th June, 1903, p. 330.
† Royal Society Proceedings, 1902, Vol. 70, p. 341.

illustrated. Instead of moving the permanent magnet, a band of iron wires *a* is moved by means of pulleys *e* and passes through a solenoid *g* of fine wire, which receives the electric impulses from, say, an elevated conductor, A. The telephone, T, as before, is connected to a fixed coil *c* wound round the iron wires *a*. The permanent magnets *dd* have like poles together near the coil *c*. In this case the magnetism of the iron wires, as they are moved through the solenoids, is reversed in sign, and during the change, the electric impulses, as before, are able to exercise a magnetic force, which so disturbs the magnetism and induces electric currents in the telephone, thus producing audible sounds. A sustained effect corresponds to a "dash," and a short effect to a "dot," in the Morse code.

Previous to the publication of Mr. Marconi's paper above alluded to, I employed, instead of a rotating permanent magnet, a battery and liquid reverser for producing a reversal of magnetism in iron wires. The arrangement is shown in Fig. 7, in which B is a battery of storage cells, C is an adjustable resistance, and A is a liquid reverser, consisting of copper plates in dilute copper sulphate solution. On rotating the inner sector-shaped plates the current in the coil D wound on a bundle of iron wires is reversed. In the original experiments the receiver of the high frequency electric impulses was attached to this coil, and a telephone to the second coil F wound on the wires. In Fig. 7 the receiver is intended to be attached to a third coil E, a device I subsequently employed. A number of experiments were made* in which it was shown that by heating the iron wires a greater effect could be produced. It is well known that raising the temperature of iron to a point a little below that at which it ceases to become magnetic, not only can increase its magnetic permeability, but also a further advantage is gained in that the specific resistance of the iron is increased. I found, also, that when the wires were stressed to the extent of 7.37 kg. per sq. millimetre, and, at the same time, subjected to torsion, the effects in the telephone were increased.

One of the latest contributions to this subject is from the pen of Professor J. A. Fleming, F.R.S.,† who automatically magnetises a bundle of iron wires by a local battery, and induces a current in a moving coil galvanometer, instead of deflecting a magnet needle, for the purpose of detecting signals. Fig. 8 is diagrammatic only of the apparatus. A bundle of wires is surrounded by three coils, D E F. E is connected to the receiver of the electric impulses. F is connected to a galvanometer G, and D is connected to a local battery B. Three keys, *a b c*, are operated by a shaft rotating at about 500 revolutions per minute, and upon the sequence of their operation the working of the apparatus depends. It must be understood that the electric impulses are being received by coil E with long and short duration in accordance with the Morse code. During every revolution of the shaft the following cycle of operations is gone through. Key *c* is closed in order that battery B may magnetise the iron wires, but in order to protect the galvanometer G it is, just previously to closing *c*, short circuited by key *a* and detached by key *b*; this goes on for a certain fraction of the time of a revolution. When it is desired to expose the galvanometer to any current which the electric impulses may induce in coil D, key *c* is first opened, key *a* is next opened, and key *b* closed: this holds for the remainder of a revolution. Five hundred times a minute the wires are left magnetised, the battery current is stopped, and the galvanometer is ready to receive any current set up by the demagnetising action of the electric impulses when these occur. For short and long times of duration of the electric impulses, the galvanometer has respectively small and long deflections of its spot of light.

In the above article I have possibly omitted to do justice to other workers in this field, but I have dealt with the subject so far as published matter known to me is concerned. Professor E. Rutherford has personally given me a description of his moving band of wire, which he used in 1900 or 1901, and which is similar to that shown in Fig. 6‡ Again Mr. Lee de Forest states§ that Professor Fessenden and another American were among the early workers in this field of research.

* See British Association Report, 1902, and "The Electrician," 29th September, 1902. Also British Specification, 14829, 1902.
† Royal Society Proceedings, 1903, Vol. 71, p. 398. ‡ "The Electrician," July 25, 1902.
§ "The Electrician," July 3, 1903.

Astronomical Notes for August.

THE SUN.

ON the 1st the Sun rises at 4 h. 23 m. a.m., and sets at 7 h. 49 m. p.m. On the same date daybreak occurs at 1 h. 31 m. a.m., and twilight ceases at 10 h. 41 m. p.m. The actual length of the day is, therefore, 15 h. 26 m.

The Sun's apparent declination at noon on the 1st will be 18° 15′ 47″ N., with an hourly variation of 37″.06, his R.A. on the same day being 8 h. 41 m. 52 s., the hourly variation amounting to 9.73 secs.

THE MOON.

The Moon will be full on the 8th at 8 h. 54 m. a.m., will reach her last quarter on the 16th at 5 h. 22 m. a.m., become new on the 22nd

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at 7 h. 51 m. p.m., and attain her first quarter by the 29th at 8 h. 34 m. p.m. She will be in apogee on the 6th, and in perigee on the 21st. When our satellite is at the full she will rise at 7 h. 20 m. p.m., and her time of rising will be at intervals of only about 25 minutes later on each succeeding evening up to the date of her last quarter, when she will rise at 11 h. 0 m. p.m. At the period of her first quarter the Moon will set at 10 h. 22 m. p.m.

Occultations will take place (1) on the 11th, when B.A.C. 8094 (magnitude 5.6) will be hidden by the Moon at 2 h. 3 m. a.m. at 54° from the true north point, reappearing at 3 h. 22 m. a.m. at 255° from the T.N.P.; and (2) on the 17th, when 63 Tauri (magnitude 5.6) will be occulted at 4 h. 13 m. a.m. at 15° from the T.N.P., reappearing 32 minutes later at 320° from the T.N.P.

The Moon will be in *conjunction* with Saturn on the 7th, Jupiter on the 11th, Mercury and Venus on the 24th, and Mars on the 27th.

THE PLANETS.

Mercury is *technically* an "evening star" throughout the whole of the month of August, but is in too close proximity to the Sun for satisfactory observation.

Venus is an "evening star" at the commencement of the month, but after attaining her "greatest brilliancy" on the 12th, she quickly recedes southwards, and is soon lost in the Sun's rays. She will set on the 13th at 8 h. 14 m. p.m., or only 46 minutes after the Sun, and hence, though *astronomically* at her *brightest*, will not appear to the ordinary observer so striking an object as she did in May and June, when she set much later in the evening, and attained a much greater altitude in our skies. To those who have neither the facilities for, nor the inclination to, pick up this brilliant planet for telescopic observation *before* sunset, a method of subduing the glare of her disc, which may be recommended, is to wear lightly tinted (or "smoked") glasses (the "sun-cap" is too opaque) during the observation, when the detail of the planet's disc may be seen free from that "boiling," which is one of the chief drawbacks to the telescopic observation of Venus. The apparent diameter which she presents to us at the time of greatest brilliancy is about 40″.

Mars is also an "evening star," but as he sets at 9 h. 30 m. p.m. in the middle of the month with a southern declination of 13° 54′ 42″, he cannot be considered a very interesting object.

Jupiter now engages our attention in the south-east early in the evening, rising in the middle of the month at about 8 o'clock. The ease with which the phenomena of his system of satellites, or at any rate *four* of them, can be observed with small telescopic assistance tends to make this planet a general favourite with the amateur.

On the 9th Jupiter presents us a disc whose apparent diameter is 44″.2.

Saturn, having been in *opposition* on July 30th, will be in excellent position for observation at the beginning of August, *southing* on the 6th at 11 h. 35 m. p.m. It is unfortunate, however, that his southern declination is still increasing, being 19° 29′ 38″ on the 4th, and reaching 19° 55′ 37″ by the 29th.

Interest will always be found in viewing Saturn's wonderful ring system, though his satellites are by no means so easy of observation as those of Jupiter. Saturn shows us an apparent disc of 17″.2 at the beginning of the month.

Uranus occupies a similar position among the stars to that of last month. On the 29th he will set at 10 h. 47 m. p.m., with S.D. 23° 20′, and R.A. 17 h. 23 m. 32 s., showing a disc 3″.6 in diameter.

Neptune is now coming to the fore again as an object for the observer armed with sufficient optical power for his detection. He will be found in the neighbourhood of μ Geminorum, and rises on the 29th at 11 h. 47 m. p.m., with N.D. 22° 17′ and R.A. 6 h. 23 m. 41 s., showing a disc whose apparent diameter will be 2″.6.

THE CONSTELLATIONS.

Looking south at about 10 h. p.m. at the commencement of the month, we shall find the zodiacal constellation Sagittarius (the Archer) on the meridian. It is very low down, however, as seen from the latitude of Greenwich, being almost on the horizon, and, therefore, does not attract the attention so much as if it were placed higher in the heavens. Directly above this group, and also on the meridian, will be noted the constellations of Serpens, Aquilla, and Sagitta; the Lyre being just past the line to the westward, whilst the Swan (Cygnus) has not yet quite reached it on the east. Pegasus (the Flying Horse) follows Cygnus as we approach the eastern horizon, whilst low down in the north-north-east *Capella*, of Auriga, shines brightly. The other "gems of the sky" at this season are *Vega* (α Lyræ) and *Arcturus* (α Boötis), the former blue in colour, whilst the latter is of yellowish tint. Boötes is now well down in the west, and closely contiguous are Corona Borealis and Hercules. Ursa Major and Lynx form a curious combination in the north-north-west, whilst Ursa Minor lies just above them.

METEORS.

Between the 1st and 16th *Perseid* meteors may be observed on any favourable night. They pursue slow paths, radiating, as their name implies, from the constellation Perseus. The radiant-point, however, moves in an east-north-easterly direction among the stars, being on the 2nd situated in α 33°.9 + δ 55°.0, and on the 10th in α 44°.3 + δ 56°.9. The principal shower is due on the 11th.

Turbine Steam Ships.

(FROM A CORRESPONDENT.)

EARLY in the present month (August) the new turbine ocean-going passenger steamer, *Brighton*—now building by Messrs. Denny and Bros., of Dumbarton, for the London, Brighton, and South Coast Railway Company—will begin running between Newhaven and Dieppe. The *Brighton* is the second sea-going passenger vessel to be fitted with the steam turbine. The first was the *Queen*, which was lately placed on the Dover-Calais service. She was built by Messrs. Denny and Bros. for the South-Eastern and Chatham Railway Company, and has proved herself the fastest steamer on the Channel Ferry.

The very first passenger vessel to be propelled by turbines was the *King Edward*; she was followed by the *Queen Alexandra*; both these ships have proved very successful, and are now running on the Clyde as excursion steamers. The latter is the fastest excursion steamer in the world.

There is no doubt that during the next few years we shall witness great developments in the turbine passenger vessel, and it may safely be prophesied that this type of steamer will eventually displace the present pattern on all the short services from England to France, Belgium, Holland, and Ireland. There are engineers who are confident that the turbine-driven liner has a great future before it, and that it will, before long, be found on the Atlantic Ferry and on other long-distance routes. There were those who considered it likely that the two new 24-25-knot Cunard liners would be fitted with turbine engines, and an eminent engineer has pointed out that the steam turbine, because of the absence of reciprocating parts, that is to say, of more or less unbalanced parts, is the ideal motor for passenger service. There was no question, he said, that the first trans-Atlantic steamship that was fitted with a successful steam turbine would have a great advantage in this respect over high-powered boats driven by reciprocating engines, and the success which has attended the installation of turbine units of great horse-power in electrical plants foreshadowed (in his opinion) the day when the steam turbine would be exclusively used in trans-Atlantic travel.

The speed of the *Queen* and the *Brighton* is 21 knots, but Mr. Parsons has lately prepared designs for a fast Channel steamer of 30 knots, and an Atlantic liner of 22 knots. With regard to the latter an interesting comparison has been made between the ordinary engines of the present day liner and the turbine engines of the liner of the future. This shows that while each vessel has the same dimensions, draught, displacement, heating surface, grate area, working pressure, and daily coal consumption, the indicated horse-power of the turbine boat would exceed that of the present liner by 3,000, and the speed by a full knot. Mr. Parsons, himself, has more than once declared his belief in the future of the turbine Atlantic liner. In a recent lecture he said:—

"In regard to the general application of turbine machinery to large ships, the conditions appear to be more favourable in the faster class of vessels, such as cross-Channel boats, fast passenger vessels, liners, cruisers, and battleships; in all such vessels the reduction of weight of machinery, and the economy in the consumption of coal per horse-power, are important factors; the absence of vibration is also a question of first importance, securing the comfort of passengers, and in the case of ships of war, permitting of greater accuracy in sighting the guns."

The principal advantages of the rotary or turbine over the reciprocating engine may be summed up as follows: Increased economy in steam and coal consumption. Increased speed, owing to diminution of weight and smaller steam consumption. Increased stability of vessel owing to lower centre of gravity of machinery. Increased safety to engine-room staff owing to absence of reciprocating parts. Perfect balancing of engines, which permits of very light engine foundations, and obviates stress or pull. Reduced size of engine-room. Reduced weight of machinery. Reduced cost of attendance on machinery. Reduced consumption of oil and stores. Reduced diameter of propellers, which gives increased immersion and obviates racing when rolling and pitching in a seaway. Reduced diameter of propellers, giving increased facilities for navigating in shallow waters.

The dimensions of the *Brighton* are as follows:—

Length	280 feet.
Beam	34 ,,
Draught	22 ,,
Gross Tonnage ...	1,100 tons

In general designs it will be similar to the twin-screw steamer, *Arundel*, built by Messrs. William Denny and Brothers in 1900 for the Brytton Company. The turbine machinery will be supplied by the Parson's Marine Steam Turbine Company, Ltd., and the boilers by Messrs. Denny and Co. With practically the same boilers as the *Arundel*, it is anticipated that the new Brytton Company's turbine vessel will travel half-a-knot faster, and, in addition, will be free from all troubles caused by vibration.

The following are some of the most interesting particulars respecting the *Queen*. Her dimensions are as follows:—

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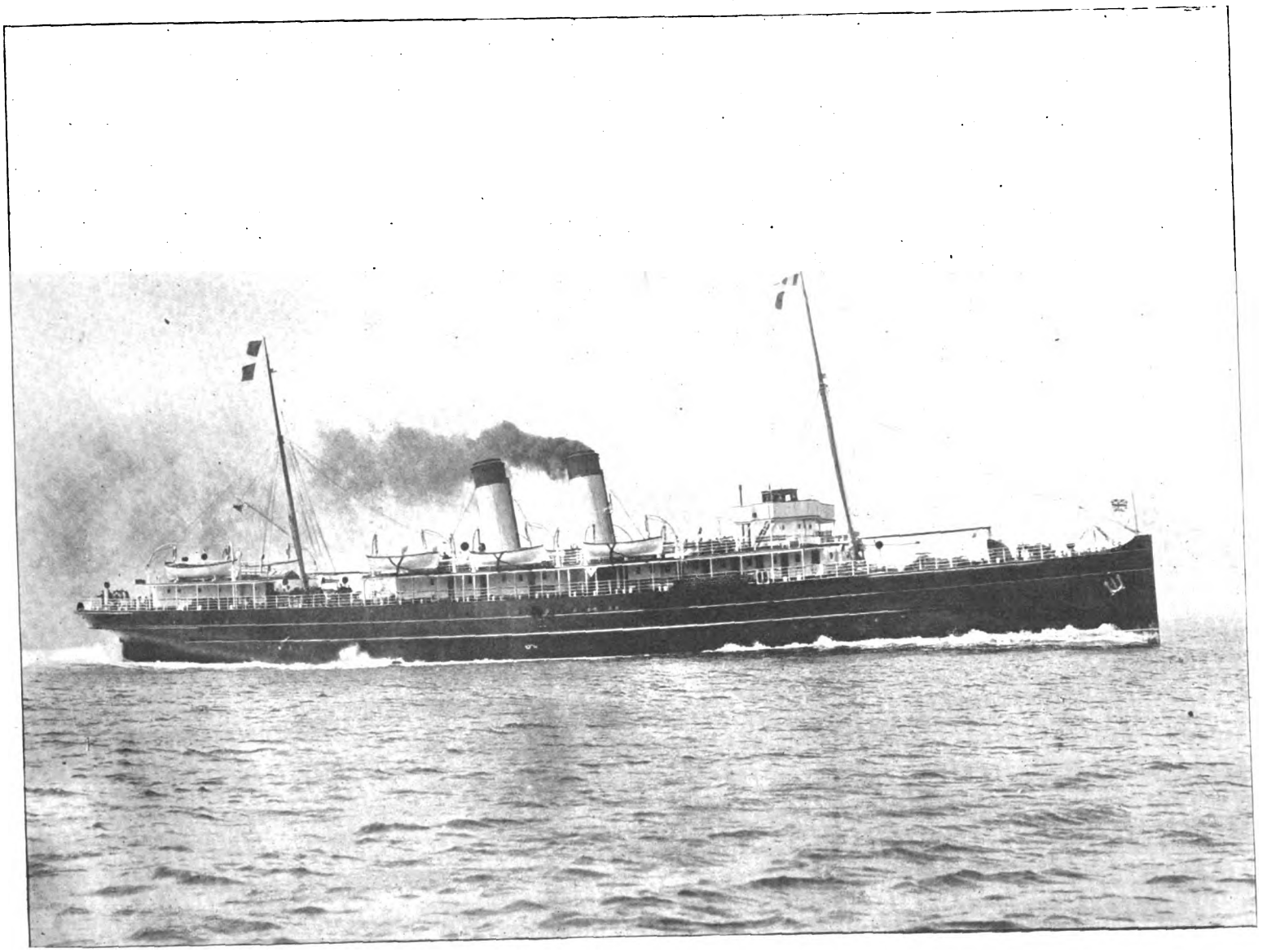
Length, 310 feet.
Beam, 40 feet.
Number of turbines, three.
Number of propellers, five.
Speed, 21-22 knots.

With regard to her beam, this (40 feet), it may be noted, is five feet broader than any existing cross-Channel steamer. This feature will give her greater stability and steadiness at sea, besides affording greatly increased deck-promenading space. To add to her steadiness she has effective bilge-keels fitted for the greater part of her length. The accommodation for first-class passengers is placed forward of the machinery space, instead of aft, as it is in all the present paddle-wheel vessels on the Dover-Calais service.

On the upper deck are the private cabins, and the promenading area on the deck will be covered by a shade or boat deck. This is a novel feature in Channel passenger steamers, and provides an agreeable shelter for those travellers who may prefer to remain on deck during the crossing.

end of each of the low-pressure turbine cylinders is placed an astern turbine which is controlled, like the other turbines, by suitable valves, which operate by reversing the direction and rotation of the low-pressure turbines and their shafting and propellers. Steam can be admitted by suitable valves directly into the side low-pressure turbines, or into the reversing turbines within the same for going ahead or astern. The centre turbine, under these circumstances, revolves idly, its steam-admission valve being closed and its connection with the low-pressure turbines being also closed by non-return valves. The builders claim that, with this arrangement, the manœuvring power of a five-screw vessel is in every respect as good as in the case of an ordinary twin-screw steamer, whilst, in going astern, they affirm that there will be none of that objectionable vibration which is always felt even with the most modern twin-screw steamers with balanced engines.

The new South-Eastern and Chatham Company's turbine steamer, *Queen*, has a speed of at least 21 knots, and this has already been excelled. She has accomplished the journey between Dover and Calais in considerably less time than that taken at the present time by



On the main deck there will be a saloon for lady passengers; while the general luncheon-room and gentlemen's saloon will be situated on the lower deck.

The second-class accommodation is at the after end of the vessel.

With regard to the propelling machinery; this consists of Parson's turbines made by the Parson's Marine Steam Turbine Company, of Wallsend-on-Tyne.

There are three steam turbines, one high-pressure and two low-pressure.

Each actuates one line of shafting. The centre shaft has one propeller, while the two side shafts also each carry one, so there are three propellers in all. The centre turbine is high-pressure, and the two side turbines low-pressure. When steaming ahead, the steam from the boilers is admitted to the high-pressure turbine, and after undergoing expansion about five-fold it passes to the low-pressure turbines and is again expanded in them about another twenty-five fold. It then passes to the condensers, the total ratio of expansion being about 125-fold, as compared with eight to sixteen fold in ordinary triple-expansion reciprocating engines.

When going full-speed ahead, all the lines of shafting, central as well as side, with their propellers, are in action; but when coming alongside a quay, or manœuvring in or out of harbour, the outer shafts only are brought into operation, thus giving the vessel all the turning and manœuvring efficiency of a twin-screw steamer. Inside the exhaust

the boats on the Channel Ferry. The highest average crossing now stands at one hour five minutes, and the new vessel has often done the passage in 55-60 minutes.

The Blondlot Rays.

THE discovery of new rays is beginning to make considerable demands on the alphabet. The X-rays, followed by the Becqueral rays, have been followed in turn by the subdivision of the rays emanating from radio-active substances into a, β, and γ rays—as well as a radio-active gas to which Professor Rutherford assigns a molecular weight of about 100. M. Blondlot has now announced a further identification of the Blondlot or N-rays, which he detected some time ago in the emanation from certain forms of incandescent burners. He has found them in the radiation from a plate of silver or talc heated to redness, and in the ordinary circular gas flame. They are invisible, but they can be detected by a small mass of incandescent gas—such as a small gas burner would furnish—and this will brighten up when the N-rays impinge on it. These new rays will penetrate black paper, ebonite, and metals, but produce no effect on a photographic plate. They can be refracted, reflected, and polarised, and are believed by their discoverer to lie beyond the red end of the spectrum.

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A New Method for Making Weather Forecasts.

AMONGST the communications made to the Meteorological Central Bureau of France at the last meeting, June 2, 1903, there was one of special interest. M. Guilbert, Secretary of the Calvados Meteorological Commission, described in a few pages, a study on weather forecasts the results of which seem worthy of note. Far from admitting the principle so long taught that "*the strength of the wind is proportional to the gradient*," *i.e.*, to the atmospheric depression, M. Guilbert demonstrated that in numerous instances the velocity of the wind is utterly out of proportion with the degree of the gradient. Sometimes there is a *strong* wind with a *slight* gradient, and sometimes on the contrary there is a light wind when the atmospheric depression has increased, so that were one to judge from these contradictions no conclusion could be deduced from strength of the wind in forecasts. However, such is not the case, for M. Guilbert has discovered a law hidden beneath this apparent disorder, a law which he enunciates as follows: "If there is a wind which we shall call normal according to the gradient, *i.e.*, a wind endowed with a certain velocity which can be measured by the atmospheric depression, there also exists an abnormal wind either through excess, *i.e.*, too violent in proportion to the gradient measured, or through deficiency, *i.e.*, too light in proportion to the closeness of the isobars.

"A *normal* wind is light for a gradient of 1 millimètre per degree (68·9 miles), moderate for a gradient of 2 millimètres; strong for one of 3 millimètres, and violent for one of 4.

"All winds abnormal by excess cause a barometric rise within 24 hours, most frequently proportional to the noted excess of wind.

"Inversely all winds abnormal by deficiency cause a barometric fall within 24 hours, more or less great according to the anomaly observed. Consequently a normal wind produces neither a rise nor a fall."

We can understand the importance of these new principles. Their discovery is the more remarkable as hitherto no method has pretended to forecast, 24 hours in advance, the barometric changes according to strength of the wind. No treatise on meteorology gives rules to forecast rise or fall of the barometer, still less the extent of approaching variations. When a depression attains any point of Europe no system makes it possible to predict the future. Will the new depression sink, fill up, precipitate itself upon distant regions? So many questions to which meteorology is powerless to reply.

With the new principles given by M. Guilbert to predict the direction of barometric changes and their approximate extent, one can determine, on the day previous, the zones of high and low pressure in Europe, sometimes trace them to the zero line of variation separating them, predict the arrival of anti-cyclones, determine the trajectory of storms, forecast the increase or decrease of centres of depression, their duration, and in some cases even their complete disappearance in 24 hours or even 12, *i.e.*, the sudden *restoration of calm* after a most furious tempest. This kind of forecast has never, as far as we know, been attempted either in Europe or America, and one can easily guess the advantages the navies of the world might gain by this method. But is this valuable idea really realisable? Can the principles given be forthwith applied? Would the promised results be attained?

M. Guilbert answers these objections in advance by the personal experiments he made from March to May. No doubt unavoidable errors, due to various causes, though always recognisable, have been committed, but several of the forecasts read at the meeting were marvellously accurate. Thus, on April 5, 1903, M. Guilbert wrote from the Central Meteorologic Bureau, "The depression over the Baltic (Stockholm 793) will disappear with a rise of about 15 millimètres in centre, and a new depression will reach Ireland tomorrow." In consequence of this double forecast, instead of giving the forecast of the Central Bureau, "Winds W. and N., strong or very strong," M. Guilbert gave "Winds from W. or S.W., light or moderate."

Next day the depression on the Baltic was replaced by a rise of 13 millimètres in centre and a storm swept over Ireland and Scotland so that the N.W. winds, very strong the day before, veered to W. and S.W., slight and moderate.

On April 15 there were two secondary movements to the S. of Ireland and on the North Sea.

M. Guilbert predicted their disappearance for the following day, and also a barometric fall in the S.W. of France and Gulf of Genoa. Next day the two disturbances mentioned had vanished, and there were two new ones in the W. of France and Gulf of Genoa.

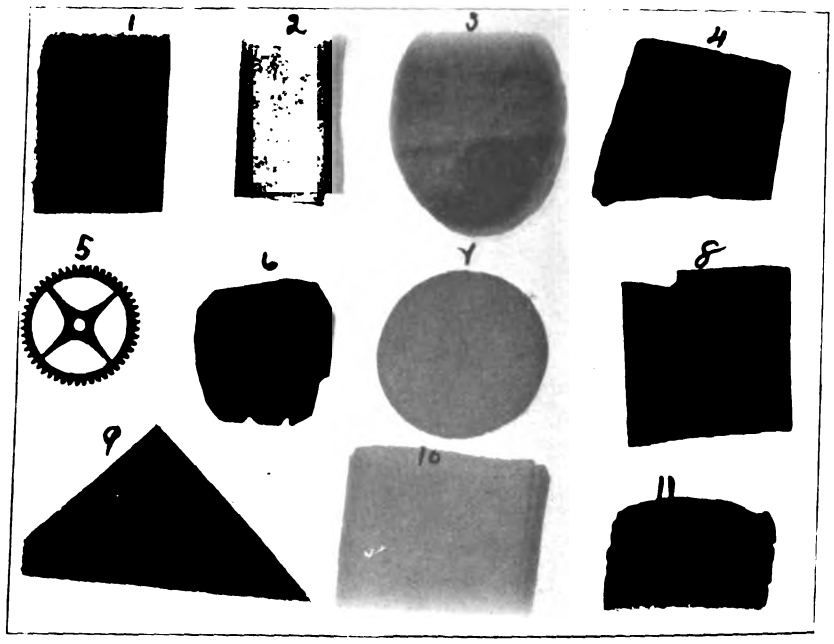
On April 29 a depression was forming over the Gulf of Lyons, and the Central Bureau predicted bad weather in the Mediterranean. M. Guilbert's forecast was that the minimum in the Gulf of Lyons would vanish, and consequently the weather would not be bad. In fact, on April 30, the *minimum ceased and the weather was good*, but a new depression made its appearance on the Gulf of Gascony, and the Central Bureau predicted S. winds, strong or very strong, in Provence (forecast still retaining the tempest cones), and strong S. winds on the W. coast of France. M. Guilbert's forecast was just the opposite. "No bad weather is possible in Provence. The minimum in Gascony will disappear and the wind will veer from S. to W. and N.W. along all the coasts."

The diagram for May 1 showed that his predictions were perfectly true. "Wind light in Provence. Minimum in Gascony vanished. Winds W. and N.W."

Prolonged study—experience excels science—of *normal* wind and *abnormal* winds on more than one occasion enabled M. Guilbert to delimit the zones of rise and fall with remarkable accuracy. For example, he forecast "a rise over the British Isles *except* Scotland" for the next day; over all the Baltic *except* the Gulf of Bothnia; all Spain *except* the S.; all France *except* Corsica. All these forecasts were strictly exact. Thus it is demonstrated that this new method, together with systematic observation of the clouds, as described elsewhere by M. Guilbert, can give great and immediate improvement in weather forecasts. The Central Meteorological Bureau of France is just the place to utilize the idea of M. Guilbert, and thus retain the honourable rank it occupies in the study of meteorology.

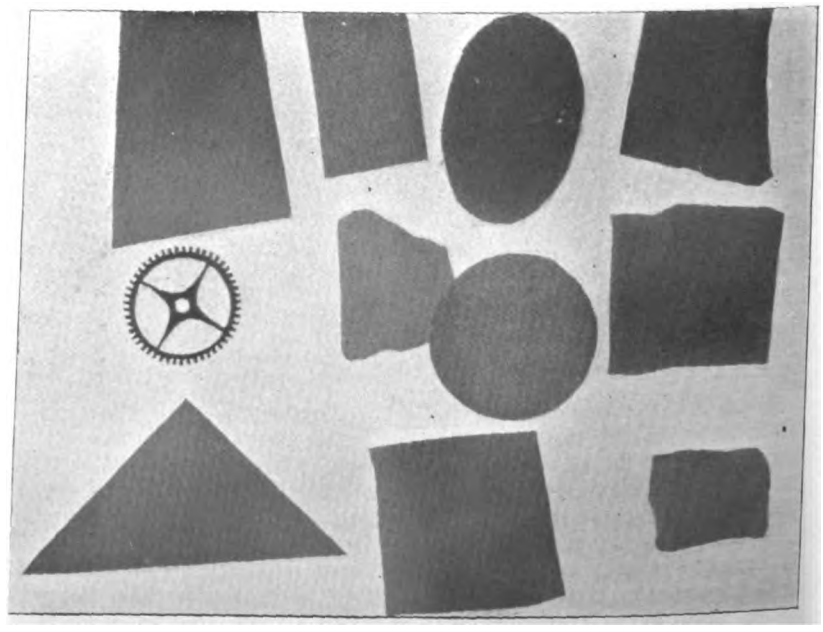
Radiographs.

MR. A. THURBURN, of Keith, Banffshire, sends some interesting results of experiments which he has been making in order to compare the effects of Röntgen rays with those produced by the emanations



III—RADIOGRAPH: (1) Mica; (2) Aluminium; (3) Lozenge; (4) Carbon; (5) Brass Wheel (6) Tinfoil; (7) Glass; (8) Wood; (9) Cardboard; (10) Red Leather; (11) Eggshell.

from radio-active minerals. Mr. Thurburn writes: "I have been comparing the effects of Röntgen rays with those produced by Uranium Nitrate and Pitchblende, and enclose prints showing the results. In



I.—Rontgen Radiograph of the same objects.

the print marked I., the objects mentioned on the key marked III. were laid on the sensitive film of an Imperial Special Rapid plate, and covered with a cardboard tray raised a quarter of an inch above the.

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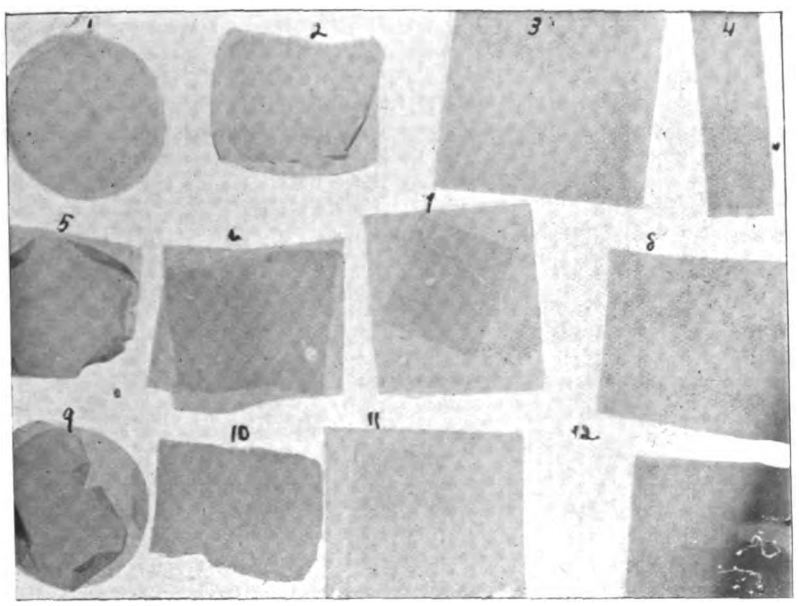
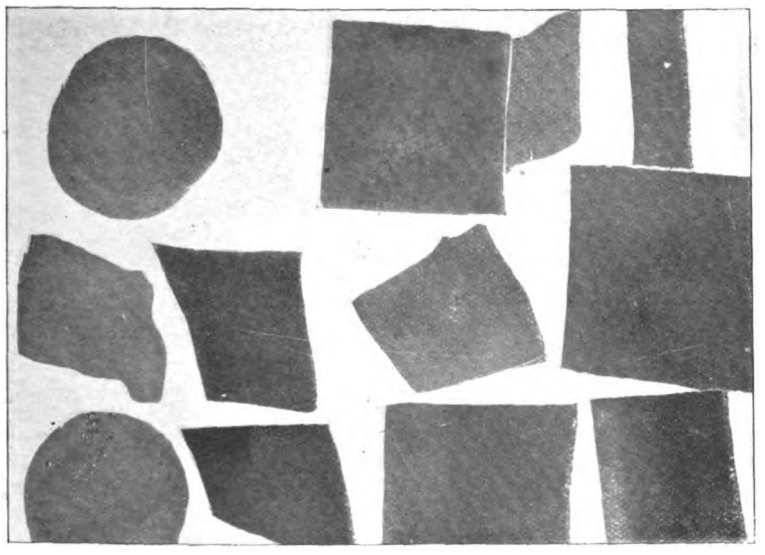
objects, which had Pitchblende scattered over the bottom. The whole was kept in the dark for 18 days and then developed, and the enclosed untoned print made. A similar plate was then covered with the same objects and exposed to Röntgen rays. The print marked on the back, II., shows the result. The brass wheel is, of course, much darker than the others, but there is not a very great variety in the depth of shading



VI—RADIOGRAPH: (1) Glasses; (2) Eggshell; (3) Leather; (4) Mica; (5) Carbon and Tinfoil; (6) Carbon; (7) Aluminium; (8) Celluloid; (9) Glass and Tinfoil; (10) Carbon and Eggshell; (11) Leather and Aluminium; (12) Celluloid and Mica.

of the remainder. In I., however, the differences in the opacities towards the Pitchblende are very great. In IV. an Imperial Special Rapid plate, with the objects specified in VI., was exposed to Uranium Nitrate, and in V. the same objects were used under Röntgen rays. This was to show that though superposing a red on a green glass produces great opacity, a red on a red, or a green on a green makes



IV.—Rontgen Radiograph of the same objects.

little difference, yet the same distinction is not found with Röntgen rays. To test Uranium Nitrate in the same way it would have been necessary to get a number of different articles all of approximately equal opacity to the Uranium Nitrate rays, but this would require a considerable time. The two prints, however, show the difference between the effects of the Röntgen rays and those from Uranium Nitrate."

Mineral Fertilization.

By EDWARD CONNER.

THE belief is steadily growing that in the work of the fertilization of the soil the action of humus plays a very important part in its association with mineral manures. It is estimated that a cereal crop in a year takes from the soil from 1500 to 1800 lbs. of humus. Unless that be restored to the soil its capability of supporting vegetable-worth will decline. Soils may be well supplied with phosphoric acid, potash, and nitrogen, and still be poor, if the supply of humus be wanting. The ploughing under of green crops such as lupin, rape, clover, &c., is a ready resource for obtaining humus. In 1890 the French Government aided in the establishing of an agronomical station at the Parc des Princes, in the Bois de Boulogne, just outside Paris; it was placed under the direction of M. Grandeau, the eminent agricultural chemist, who is besides a distinguished practical farmer on his own estate in Lorraine. The site of the experimental farm is a poor sandy-gravelly soil, with very little humus in its composition, and very deficient in the mineral elements for the nutrition of plants.

Professor Grandeau at once set to work to reclaim the soil. He removed the wild vegetation, of which broom was the principal, and buried it in the soil, which was trenched to the depth of two to two-and-a-half feet. The land received an application of stable manure at the rate of 3 cwts. per acre—which was little. However, that and the scrub, buried during the trenching, was all the organic matter which the soil received. Stable manure is known to be the best substitute for humus. The portion of soil destined for experiments was divided into 16 plots, of 6 perches each. Plots 1 and 16 were cropped, but never manured; they were retained for standards of comparison—tell-tales, in a word. The other fourteen divisions were cultivated, the crops being cereals, potatoes, and forage maize. Phosphoric acid was supplied from phosphates under various forms, obtained from different sources—brut, mineral phosphate, superphosphate, and pure crystallised phosphate, at the collective rate of 2¼ cwts. per acre, plus 1½ cwt. of kainit, for the potash.

That was the mode of culture and of manuring pursued on the fourteen plots from 1892 to 1897—a period of six years. The *débris* of the crops constituted the only organic matter which the soil received. In 1898 it was decided to renew the mineral manure, and so restore in a great measure what was taken away. Thus the fourteen plots received at the rate of 1½ cwt. per acre of phosphoric acid, in the form of mineral phosphates, superphosphate, and basic slag of different degrees of solubility. The kainit or potash was renewed, but at the rate this time of 3¼ cwts. per acre. The reclaimed soil had now been nine years under cultivation—cereals, potatoes, and forage maize—so it was decided to commence, in 1900-1901, the experiment of introducing into the soil, a certain quantity of organic matter, almost wholly destitute of phosphoric acid, and thus determine how the assimilation of that element would be affected in the yield of the products. Dutch peat or turf was selected. In October, 1900, 15 cwts. of the turf were distributed over the moiety of each of the 14 parcels of soil corresponding to a rate of 20 tons per acre. The other half of each plot received no peat; they were left so, for comparison purposes. But parcels 1 and 16, which received no enrichment since their reclamation nine years ago, had one of their moieties given the same dose of turf as the other plots; the other moiety got none. The analysis of the peat yielded the following: Organic matter, 81·61; water, 17·00; mineral matters 1·59—total, 100. Further, 100 grammes, or 3½ ozs., of the turf, contained 0·gr. 765 of organic nitrogen, but of no use to vegetation until converted into the nitric state; 0·gr. 028 of phosphoric acid, and 0·gr. 006 of potash. Thus the 20 tons of the turf per acre conveyed to the soil 17 tons of organic matter, 3 cwts. of organic unassimilable nitrogen; 40 lbs. of phosphoric acid; and 38 lbs. of potash. The quantities of phosphoric acid and potash were too small to exercise any influence on the plants cultivated on the plots. The soil being very poor in lime, the organic nitrogen of the turf could only nitrify, and could not tell on this season's products.

As already observed, the plots were divided into two parts; those dosed with peat, and those not so. Each of the moieties were thus again sub-divided into two parts of equal areas, making three parcels per plot. One of the sub-divisions received mineral manure, according to the full dosed portions—viz., 260 lbs. of nitrate of soda per acre for potatoes, and 88 lbs. for the cereals. There was now a series of three experiments. First, cultivation on a mineral manure with nitrate; secondly, cultivation with a mineral manure and turf, but no nitrate; and thirdly, cultivation with mineral manure, turf, and nitrate. The influence of the mineral, the organic nitrogen, and the nitric nitrogen can thus be compared. Bear in mind the object of the experiment is to ascertain the action that organic matter would be able to exercise upon the assimilation of phosphoric acid by the plant.

The fertility of the black earth of the soils of Russia is attributed to the preponderating *role* played therein by their humus. The humus contains a considerable proportion of phosphoric acid, in a particular state of combination with organic matter, and that the roots of plants absorb with facility. All the soils in question contain this valuable black substance, humus possessing from 1 to 15 per cent. of phosphoric acid. Now the connection between that humus and the quantity of the acid could reveal an interesting indication of the probable fertility of a soil. The black matter is a kind of digestive of phosphoric acid, that it places in a form immediately assimilable, at the disposal of the plant. M. Risler, since 1858, has drawn the attention of the agronomic world to that important fact. He showed that the organic matter dissolves much more energetically the phosphate of lime than water charged with carbonic acid.

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The Heat of the Sun.

BY E. S. GREW.

IF the value of a discovery were to be measured in the impulse it gave to scientific thought, then radium might well be considered to be worth even more than that £200,000 a pound which M. Curie has assigned to it as its value. Some of the most remote of physical and astrophysical problems have been illumined by its rays; and it does not seem unlikely that the emanation of incomplete atoms and electrons which it pours forth may help to a comprehension of the source of the energy which radiates from the sun. For millions of years the sun has been pouring forth energy; how is it able to continue this enormous expenditure of heat and light and electricity—continually exporting without any substantial imports. Sir Robert Ball, in a recent review of Helmholtz's theory, pointed out the difficulty experienced in accepting that theory as a sufficient explanation. According to Helmholtz's theory the sun is shrinking. It shrinks sixteen inches in diameter daily; it has been shrinking daily ever since it was a great gaseous nebula, extending over a millionfold greater extent of space. Now, the molecules of a body—we may, for clearness, think of a gaseous body and of the molecules of a gas—are in constant vibration while the body is radiating heat. If heat is added to the body, the rapidity of the motion of the molecules increases. Conversely, if the rapidity of the movement of the molecules increases, more heat is given out. Now, the falling in of the sun's circumference due to the sixteen inches of daily shrinking gives these molecules some distance to fall. It is not a great distance, but there are a great many molecules. Their motion is increased by their daily drop of sixteen inches. Consequently, this addition to their velocity adds to their heat, and thus by the sun's shrinking the supply of radiated heat is lifted towards the level of the expenditure. But, Sir Robert Ball proceeded to show, this is not a complete or a completely satisfactory explanation. We may take it that in shrinking from its nebulous form down to its present dimensions the sun has given out heat equivalent to about 3,400 times its own mass in coal. Each coal unit would have lasted the sun 2,800 years. If we continue this calculation, and seek to find the number of coal units that the sun will have consumed between the time it was a gaseous nebula and the time when it shall become a solid body as dense as the densest substance known—platinum—we find that it will have consumed 8,300 coal units. In other words, roughly speaking, 24,000,000 years will have elapsed. But 24,000,000 years between the sun's gaseous nebulous state and the state in which it will become at least as cold as the earth is now, and cease practically to give out heat at all, is not enough. We know by various considerations that this estimate is too small, and, therefore, we must begin to cast about for other possible sources of the sun's heat.

The sources to which Sir Robert Ball intimated that we might look were those electrified corpuscles which radium has taught us can emanate from matter. "Emanate" is not a good word to use in this connection, for it fails to convey an idea of the speed of movement with which these streams of particles are endowed. According to Sir Oliver Lodge and Professor J. J. Thomson, the "electrons" shooting out from radio-active substances had speeds comparable to the speed of light. (Their speed is, on the average, only half that of light; but for the purposes of this argument we may assume the speed to be about the same.)

Mr. E. W. Wilson, of Daramona, when the movements about Nova Persei were observed, suggested that the new star itself was not moving, but that the light from it was illumining the hitherto dark nebula surrounding it;* and the accuracy of this explanation has subsequently been confirmed by observations of the spectra of the original star and of the illumined spaces about it.† We have, therefore, in the heavens, an example of a great gaseous nebula being reached by some emanation from a central blaze—just as the emanation from a speck of radium bromide will illumine a screen of barium platinocyanide, or zinc sulphide, or blende. Let us imagine that the illumination thus effected is caused by emanations of the kind proceeding from radium, emanations of unstable atoms, and fragments of atoms. Consider the enormous energy that matter moving at this speed would have. A pound weight moving at 180,000 miles a second would develop an energy equal to 500,000 tons of coal. A single gramme, so moving, would be able to lift the British Navy to the top of Ben Nevis. And if, in the whole past of time, a quantity of matter equal to the earth in weight had rained into the sun with such a speed as 180,000 miles a second, then the sun's capacity for giving out heat would have been doubled.

The Great Nubula in Orion.

Sir Robert Ball adapted this consideration to a view of the energy received from other bodies by nebula—for instance, by the great nebula in Orion—the accompanying splendid photograph of which has been

* This explanation was simultaneously put forward by Professor Kapteyn.
† Professor H. H. Turner, Royal Institution.

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lent to the ILLUSTRATED SCIENTIFIC NEWS by Mr. E. W. Wilson, F.R.S., of Daramona.

If a spectator on the sun compared the space in the heavens occupied by the earth with that occupied by the great nebula in Orion, he would find that the earth occupied only one-two-hundred-thousandth part as much space as the Orion nebula. Therefore we have this fact, that the great nebula in Orion, though it is a million times farther from the sun than we are, is receiving 200,000 times as much heat a day. Now there are visible to our telescopes perhaps about 120,000 nebula—all giving out heat as the sun has been for ages giving out heat. If the nebulæ of the sky had all received heat from the sun then—and here was the point—the solar nebula had received heat from the stars in its turn; and so had received an enormous addition of energy to the resources which its own molecular movement give to it.

To this suggestion a most valuable corollary has been added by Mr. E. W. Wilson, who is the chief authority on the temperature of the sun. Mr. Wilson points out that the property which radium has of giving out heat without cooling down may afford a clue to the energy in the sun and stars. He has calculated that if there were 3.6 grains of radium in every cubic metre of the sun's volume, the whole output of solar energy would be supplied by its radiations, even if we neglect the fact that radium at solar temperatures may be capable of more energetic radiation..

In Sir Oliver Lodge's recent paper on "electrons" he drew attention to the attractions of the theory in explaining the effect of emanations from the sun, and of repulsion of small particles by the sun's light, and by the sun's probable electrifying effect. The earth, he continued—and, as well as the earth, all heavenly bodies, from nebulæ to the tails of comets—was, in fact, a target exposed to cathode rays, or, rather, to electrons emitted by suns. In the case of the earth, its gradual accumulation of negative electricity was a natural consequence of the sun's electric bombardment, and the fact that the torrent of particles constituted an electric current gave an easy explanation of one class of magnetic storms, which have been long known to be connected with sunspots and auroræ. The electric nuclei would also serve as centres for condensation of atmospheric vapour at high altitudes, and so be liable to affect rainfall.

The repulsion of small particles by the sun's light (or other emanation) has been put forward as an explanation of the deflection of comets' tails. In some recent experiments made by Mr. E. G. Nichols and Mr. G. F. Hall, the investigators sought to reproduce the conditions to which a comet's tail is subjected as it approaches the sun. A stream of the dried spores of a puff ball—so chosen because of their extreme lightness, the lightest material particles that could be found—were allowed to pour through a sort of hour-glass vacuum tube. Mingled with them was a stream of heavy particles of emery sand. The vacuum tube was as near perfection as the best mercury pumps could make it: and the specific gravity of the puff ball seeds was only a tenth of that of water. While the mingled stream of particles was pouring through the orifice of the vacuum hour-glass a beam of light forty times as strong as that of sunlight was turned on the particles. The expected happened. The emery particles dropped down perpendicularly. The puff ball particles were blown aside as if by a draught. So far, the experiments seemed to be conclusive and satisfactory; for the angle of deflection, when measured, agreed with that which should have been caused by the previously computed effect of light pressure. But Mr. Nichols has now found an error in the calculation by which it appears that the observed effect was ten times too great. The effect was, therefore, probably caused by the movements of the air molecules which, even after the most rigorous application of the air pump, still remained in the vacuum tube. Sir William Crookes has recently pointed out that even if the air in a vacuum tube is reduced to a millionth of an atmosphere, there still remain millions of air molecules to move about. When moving about they are capable of influencing the movements of material particles to a very appreciable extent, as may be seen in the case of the silvered and blackened vanes of the so-called radiometers that one may see in opticians' windows. However, Messrs. Nichols and Hall are going to repeat their experiments with lighter particles, and better vacuums—it would, perhaps, be possible to make use of liquid hydrogen to perfect the vacuum—and their interesting experiments may still throw light on what is now one of the most fascinating of scientific speculations.

Tuberculosis in France and German Sanatoriums.

OF late years the studies on tuberculosis have been multiplied. The scientist has been engaged in laboratory researches, with an enthusiasm not yet rewarded by success, endeavouring to discover the lymph which will render the organism proof against this disease. Practitioners long ago explained the conditions which favour development of the malady. It is contagious and has a predilection for badly-fed, badly-clothed, over-worked individuals. Alcoholism also favours the disease. If one succeeded in effectively isolating all the sufferers there would be hope of preventing spread, and as a cure can often be obtained, such isolation need not be permanent. Want and alcoholism contribute to progress of tuberculosis. If, as soon as a workman is attacked or simply menaced, one provided him with substantial food, rest, fresh air, the evil would be checked. It is estimated that there are 500,000 persons in France suffering from tuberculosis, amongst whom the annual mortality is 150,000. More than three-quarters of them are, if not indigent, workmen incapable of working regularly. How can they be treated, cured, made as little dangerous as possible for the population? The problem is both medical and economic. It is discussed in numbers of memoirs and at scientific congresses. Recently it was again broached at the meeting of the International Central Bureau for the Prevention of Tuberculosis. This Bureau, founded scarcely two years ago, met for the first time at Berlin in October, 1902, and at Paris, May 6, 1903, with the object of arranging a Congress to be held in Paris during October, 1904. The mission of this Bureau is to facilitate, by every available means, the attempts made by various nations to combat tuberculosis. In particular, it encourages scientific studies and researches, and carries on an active propaganda amongst the public. It appeals to the Governments of all nations to second its work by suitable laws and regulations. Its members represent 21 countries. At the May meeting Dr. Brouardel exposed the guiding principles for the anti-tuberculosis campaign, which we shall epitomize. There are fairly precise statistics for France, Prussia, England. In 1888 to 1901 the mortality was 39 in France, 21 in Prussia, and 19 in England per 10,000 inhabitants. There is a slight decrease in all these countries, especially France. We cannot isolate all the consumptives, but it would be possible to otherwise care for the indigent who are admitted to the Society's hospitals. Instead of scattering the sufferers amongst the Paris hospitals, where they spread the disease, they might be gathered together in one or two special establishments as far as possible near the rural districts. Those only slightly attacked could be sent to hospitals outside the city. They would be in more healthy surroundings and expenses would be less. The Germans have instituted special establishments, viz., the sanatoriums, which have been imitated in France. The Assurance Offices have multiplied them in Germany. For these offices the sanatorium is the weapon of battle. They only intervene when the workman is sick, and have no hand in preventive measures. Compelled to pay the patient a sickness indemnity, the administrators quickly realized the fact that the funds went mainly to consumptives, that duration of their lives, or, rather, of disease, was two or three years, and that all succumbed. Thus the funds were uselessly sacrificed. The thought then suggested itself that the success of sanatoriums for the rich pointed out the path to be followed, and 67 sanatoriums were founded for the 15,000,000 persons obligatorily assured, where 36,000 patients can be accommodated yearly, viz., 24 per 10,000 assured. The result seemed satisfactory, as not only were the lives of the workmen prolonged, but expenses also decreased.

The researches of the Central Assurance Administration of the Empire supply the following statistics. It was noted that in the years 1897, 1898, 1899, 1900, 1901, the cases of cure, probably without any period of invalidism, after a given time, were 68, 74, 74, 72, 77 per cent. of the assured consumptives constantly treated. *Cures within the meaning accepted by the Companies*, viz., workmen capable of executing one-third the amount of work done by a healthy workman, observed during the year 1897, were maintained to the end of 1898, and also in 1899, 1900, 1901, amongst 44, 30, 30, 27 per cent. of constantly-treated persons. It is also to be remarked that some patients in a more advanced stage, who left the sanatoriums without any improvement in their condition, were subsequently found to be perfectly able to earn a livelihood. It would be unjust not to ascribe this good result to the treatment, hygienic education, and rules of life learned by the patient during his stay in the sanatorium. The Assurance Offices actually dispose of a number of sanatorium beds, sufficient for members, to treat 36,000 consumptives per annum, in 15,000,000 assured, viz., 24 per 10,000. They will in future only establish others to meet demands and devote their funds to two kinds of institutions, one for examination before going to the sanatorium, from which incurables will be sent to the less expensive hospitals, whilst the weak, not consumptive, will be drafted to the second establishment, after the sanatorium, intended for convalescents leaving it when the three months imposed by the financial regulations, not medical, have expired. As Dr. Brouardel remarks: 1. The system of Assurance Offices makes it possible to care for the workman from the commencement of the illness; it is realization of precocious diagnosis. 2. In the sanatorium the workman has pure air, excellent food, instead of the contaminated air and imperfect nourishment of his ordinary life. Finally, he gives up the habit of drinking alcohol. Let us increase the number of sanatoriums in France as far as possible; modify some of the hospital services so as to make them like the sanatoriums. This is one of the valuable features in the attempt to check consumption by isolation and treatment of the afflicted. But we cannot deal with all the consumptives in this manner. Some but lightly attacked can remain in their homes, and, if aided, do a certain amount of work, without being too dangerous to their associates. One may hope to cure them. For such as these we can recommend the Anti-tuberculosis Dispensary. Mr. Calmette has given the conditions in the following terms: Organise in all populous centres, especially in manufacturing towns, special dispensaries for prevention of consumption, by hygienic education of the people and assisting in their homes the many sufferers who cannot be received in hospitals or sanatoriums. The chief mission of these dispensaries should consist, not in consultations nor distribution of medicine, which is the work of Charity Bureaux, but in *finding*,

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attracting, and *accommodating* workmen attacked by, or suspected of suffering from, pulmonary consumption; giving them as frequently, and as long as necessary, advice for themselves and family. Distributing amongst them when unable to work, food, clothes, bedding, pocket spittoons, antiseptics, cleansing their houses and disinfecting them at regular intervals. Obtaining for them, if necessary, more healthy dwellings. Washing their linen gratuitously to prevent contagion in and outside of the family; taking all requisite steps in the matter of private charity; employers, etc., to obtain assistance for restoring the individual to health and sending him back to work.

A dispensary in favourable circumstances assisting *100 families daily* would expend a sum of 4,500 francs, or £180 per month, to which one might add about 1,500 francs (£60) for general expenses, giving a total of 6,000 francs (£240) per month and 72,000 francs (£2,880) per year. With such a budget one would assuredly succeed, by the most simple and practical means, in organizing, efficiently, a system for uprooting consumption in working centres. However, the tuberculosis dispensary, such as we understand its functions, is, and can only be, a bureau for recruiting and observation. It must act like a screen through which only those who are almost certainly curable can pass to the sanatorium. It should also take charge of the sufferer when he leaves the sanatorium, aid him, and continue hygienic supervision. Finally, it should devote attention to all consumptives, not eligible for sanatoriums, whose number is legion. However, no matter how well organized, it is not self-sufficient; it must be supplemented by the *popular sanatorium* on the one hand, and a *hospital for incurables* on the other. The dispensary is not a panacea. We must not, I repeat, regard it as *a very efficient instrument of cure*, and in this respect it will never take the place of the sanatorium against which endeavours have too often been made, with the object of stupid polemics, to pit it. It would be absurd and deceptive to ascribe virtues to it to which it could never aspire! Certainly, supplying the poor with means to avoid misery and live in more healthy conditions is not the means of curing many. Perhaps some amongst the most easily cured will triumphantly resist, thanks to the rest and comparative comfort given them. But for the other sick, the most numerous, alas, who understand the gravity of their condition when too late to arrest progress of the disease, those who find no place in the hospitals, or who, burdened with families, endeavour to earn a living until they drop down exhausted and dying, the dispensary will accomplish a truly useful work, a truly social one, by taking them under its protection. It will aid them according to needs, afford them the means of finishing their lives without detriment to others, without spreading contagion and wretchedness in their wake. This is how the *rôle* of the dispensary should be envisaged, and the reason why the most ample development should be given to this French conception of the anti-tuberculosis movement, the only one we can entertain until the day when our sanitary legislation, provident and workmen's assurance associations, make it possible for us to fight the disease by *sanatoriums, healthy dwellings, cheap beef-steaks*. Since 1890 the amount contributed to the various anti-tuberculosis works by public charity is over 30,000,000 francs (£1,200,000).

The fight against the spread of tuberculosis has two aspects which are equally important. It concerns consumptives, for whose cure endeavours should be made, and persons more or less predisposed to the disease, who must be placed in conditions where they can more effectively resist its attacks. As far as possible consumptives should be isolated at commencement of the ailment. This is impossible with the great majority. Law and humanity prohibit it in the case of persons in easy circumstances. The indigent would tolerate it, but the Charity Budget could not support the expense. The sanatorium realizes the system of isolation when possible and acceptable. It enables scientific treatment and facilitates education of the patient from the hygienic point of view. On leaving the establishment he becomes, thanks to this education, more competent to look after himself, and if not cured, knows what precautions to take to avoid spreading the contagion to those with whom he is brought into contact. This scientific treatment and education can be given by dispensaries which are more easily established than sanatoriums. We have specified the services they can render according to Dr. Calmette. The disease is contagious; but want, congenital or acquired weakness, favour it to an extraordinary degree. There is another side of the question—what can we do for those predisposed to pulmonary consumption? Children are in this category who have lived a long time in towns. The fresh air associations, which send them to the country or seaside for their holidays, render valuable services. In a lecture on the "holiday colonies," Mr. de Félice, speaking on behalf of one of the holiday associations, remarked that for children of 10 to 12 years of age there was an average gain of 2 lbs. in weight and an increase in width of chest of 7-10ths to 1.1 inch, and that, a yet more important point, after an insignificant relapse on returning home, development of these children continued to improve all the year, much more so than that of their companions. The town of Lyons sends 450 children yearly to Sévérin (Isére). Rural colonies have also been founded by Bordeaux, Soulac, Arcachon, etc.

In the Departments of the Loire and Haute Garonne, 1,500 children are sent to the mountains every year by the associations. Various kindred establishments are also very useful, *e.g.*, the sailors' sanatoriums, 28 in number, with 3,883 beds. Then there are two others with 410 beds, for which payment is demanded. The greater number exclude consumptive children, and the remainder receive them. Results are excellent. Cheap healthy dwellings are needed for adults in general and workmen's families. Unhealthiness is not confined to the house; the conditions of modern life compel people to live in insalubrious towns. The child is taken by the schools, the adult by the barracks, the artisan by the workshop, the student by the lecture-room, libraries, laboratories, clerks and functionaries by offices and Government establishments. When travelling, vehicles and railway carriages, too often contaminated, are utilized. Those who enter hotels often take the place of sick persons, after whose departure no precautions had been taken to protect newcomers against possible contagion. Indigent and sick, they enter the hospital where everything menaces with contagion. This peril of life in common, inherent to the very progress of civilization, is constantly increasing, and explains the more and more threatening aspect of tuberculosis. These inconveniences, mentioned by Dr. Brouardel, can only be palliated to a slight degree. However, they can be attenuated by a better arrangement of buildings, isolation, or at least removal of pronounced consumptives to a distance from certain towns, finally by their education in hygienics. The noxiousness of milk and flesh meat from tuberculous animals has been contested, but not so alcohol, the ravages of which are ever gaining ground. Alcohol makes the consumptives' bed, said Landouzy. The influence of the anti-alcohol societies in France has already had some result, especially amongst the middle classes. Let us hope that it will reach all classes. Such, in brief, are the principles to guide us in the fight against tuberculosis, which we have culled from Dr. Brouardel's address.

The Bermuda Islands.

A Marine Biological Station.

A PROJECT is on foot, which has every prospect of realisation, for the establishment of a Marine Biological Station at Bermuda. The legislature of the Colony has had under consideration for some time a scheme towards this end, and is now prepared to erect a suitable building, and undertake its equipment, in part, at any rate, after the manner of similar institutions, such as, for instance, those at Naples, Woods Hall, Massachusetts, and Plymouth. It is also desired to construct an aquarium for the use of the public.

In view of the important scientific work so long carried on in the Bermudas by zoological and other investigators of the United States, the accessibility of the islands, and their tropical interest favouring frequent visits, a desire very naturally arose for the promotion of a laboratory which might serve as an adjunct to the current studies of American workers in the departments of marine and kindred research. It is quite possible that the initiation and maintenance of a biological station would have revealed no insuperable difficulties, even if detached from the auspices of the Government of the islands, while, in conformity with the traditions of scientific practice its tables would have been open, irrespective of nationality, to all who chose to use them. However that may be, the decision of the Bermuda authorities to establish an island laboratory under the official ægis is deserving of commendation, more particularly since it is understood that the active co-operation of scientists of the United States has been secured, co-existent with a cordiality of sentiment that leaves nothing to be desired. Under a suitable scheme of joint control there can be little doubt that the laboratory will enter upon a successful career.

An observational establishment of the character thus indicated directs attention to the geographical and physical features of these reef-bound islands, remarkable alike for their isolation from other tracts, and for the depth of the waters which form their environment. Much valuable information respecting the scenery, climate, production, physiography, fauna, and geology, is opportunely afforded by the monograph contributions of Prof. Addison E. Verrill, of the Connecticut Academy of Arts and Sciences. This able biologist has made two expeditions to the Bermudas, one in 1898, accompanied by three students from the Sheffield Scientific School of Yale University, the other in 1901, when, with his son as colleague, large collections were formed, and a series of photographs obtained, both geological and zoological, including numerous examples of living animals beneath the waters, and of living birds in their natural haunts.

Permanent settlement by the English was effected in 1612, though the islands were discovered earlier, about 1511, prior to which no human being, not even the aboriginal, had trodden the soil. At present this equable and favoured spot is a prime resort in the spring and winter months for American visitors, the distance from New York being but 675 nautical miles, allowing of the ocean run completed in some sixty hours.

The characteristic feature of the Bermudas is the chain of limestone reefs, which everywhere encircles the comparatively limited land area; these reefs cover about 250 square miles. There is one peculiar form, not seen elsewhere, known as the "serpuline atoll," or "boiler," this being a detached reef with a rim and central depression, the former set up by a solid, raised, living crust, composed principally of the hard convoluted tubes of serpulæ, barnacles, small black mussels, and some incrusting corals. The "boilers" constitute conspicuous ocean objects, and at times of heavy seas present fascinating cataract displays.

Bermudian caverns and grottos, too, have always attracted notice, hung as they are with massive or network draperies of stalactitic

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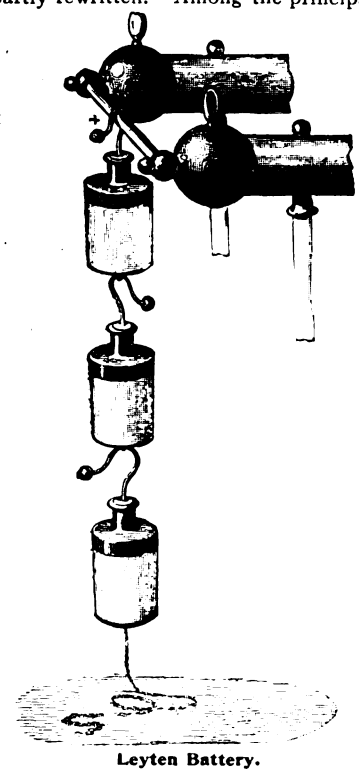
origin. Some are submerged in clear sea-water many feet deep, the translucent homequarters of fishes, octopi, and other marine fauna. Of known species of fishes there are about 200, and of marine invertebrates about 900 species.

Whether we consider the unique and almost problematical situation of this oceanic coral island, the flora and fauna, the geology, the climate, or the general scenery, there is much that affords special ground for satisfaction that an authoritative scientific station will, before long, find habitation in our distant possession.

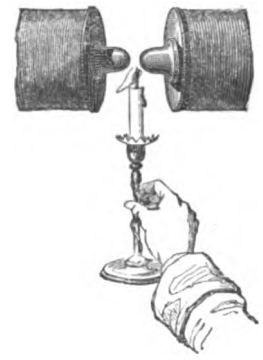
REVIEWS OF BOOKS.

Electricity and Magnetism, by G. Carey Foster and Alfred W. Porter. (Longmans, Green, and Co.) 10s. 6d. This is the second edition of this work, revised and partly rewritten. Among the principal additional matters



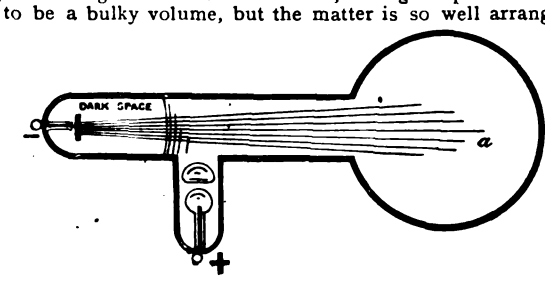
Leyten Battery.

introduced are: the theory of electric images, as applied to the mutual electric influence of spherical conductors; a discussion of the stresses in the dielectric medium; the water-dropping electric machine; the idea of ionisation of electrolytes; the propagation of electric waves along a "concentric cable," and of a plane wave in an unlimited isotropic medium; the properties of the Cathode stream, of Röntgen and Becquerel rays; the Zeeman effect, and a brief account of recent investigations bearing on the theory of electrons.



Movement of a Gas in a Magnetic Field.

The book forms an excellent elementary treatise on the subject, being put in clear and succinct language, and practically covering the whole range of electricity and magnetism. Such a work, brought up to date, might be expected to be a bulky volume, but the matter is so well arranged and con-



The Cathode Stream.

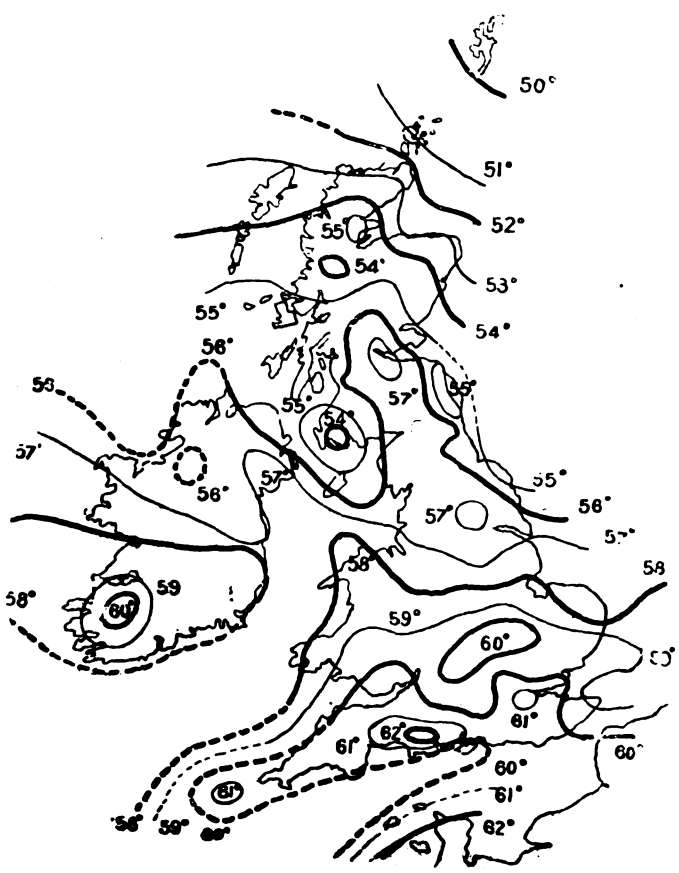
cisely put that it is contained in 560 pages. There are a great number of clear illustrations and diagrams, which add greatly to the facility of mastering the theories and effects described. We can thoroughly recommend this book to anyone wishing to gain a knowledge of the subjects.

The Book of the Daffodil, by the Rev. S. Eugene Browne, B.A., (John Lane) 2/-, is one of the series of handbooks of Practical Gardening edited by Mr. H. Roberts. It is a very complete little work treating exhaustively of its subject. The history of the flower is traced back to the days of Homer, but it is only in recent times that it has come to be studied as a garden flower. The author states that he has cultivated no less than 200 varieties. The genus Narcissus is divided into three large groups, each of which is sub-divided into species, and into many variations. A number of excellent photographs represent the leading types of each. The soil and situations suitable to the plant, the methods of planting and of gathering the flowers, the enemies and diseases, the cross-fertilization and seedling raising are all carefully gone into. All gardeners and those interested in the propagation of beautiful flowers will find this little work of great value.

"Mathematical Crystallography," by Harold Hilton. (Oxford University Press) 14s.

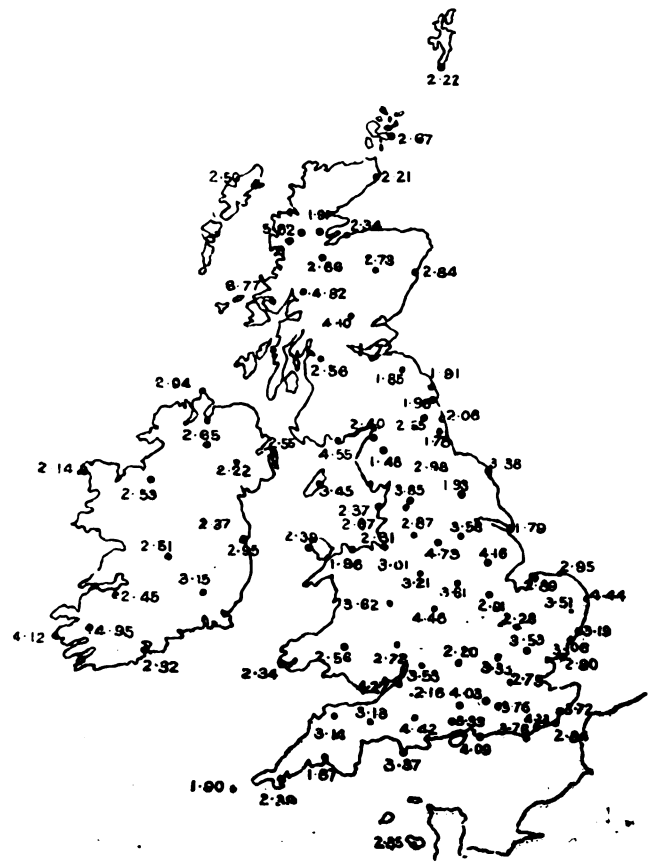
LAST YEAR'S WEATHER.—AUGUST, 1902.

DISTRIBUTION OF MEAN TEMPERATURE.



Temperature in South half of Kingdom normal, but in Northern districts below average. Highest readings in North Ireland and Scotland did not reach 70°, but in London attained 81°. Lowest readings, 34° at Braemar.

RAINFALL.



Rainfall in excess of average in Eastern, Central, and Southern Districts less than normal elsewhere.

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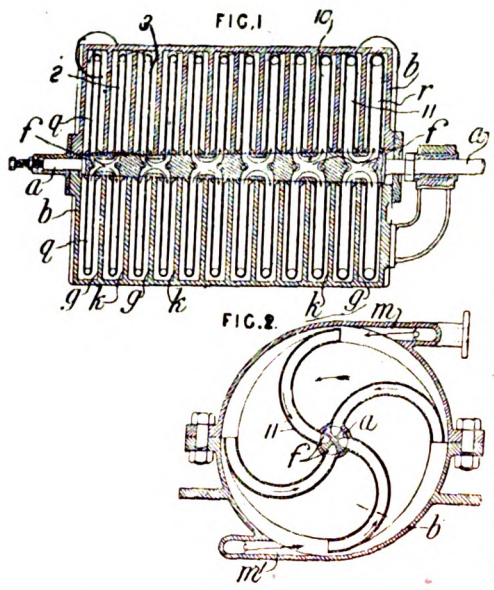
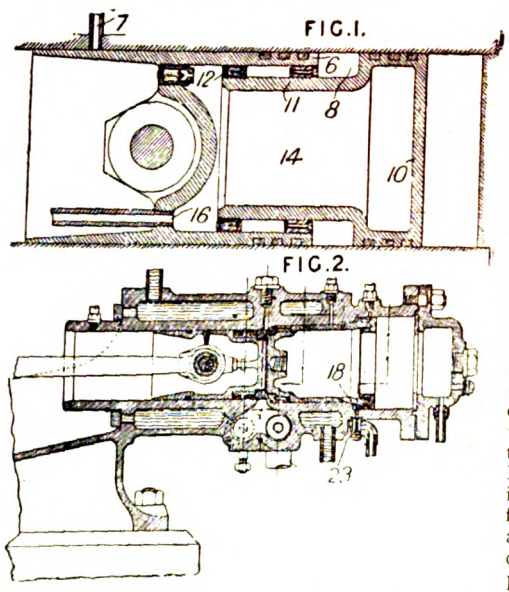
Recent Patents.



6196. Reaction wheels and pumps. SCHERRER, J. W., Stoupky, Jekaterinoslav, Russia. March 13.

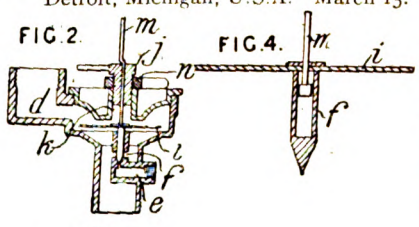
A rotary motor of the Barker's mill type, applicable for use as a pump, is shown in Figs. 1 and 2. The tapered shaft *a* has a number of pairs of four-armed wheels 2, 3 . . . 10, 11 and terminal wheels *q*, *r*. A jet of steam or gas impinges on the hollow arms of the first wheel *q*, passes through a passage in the shaft into the wheel 2 of the first pair, and is then led through the wheels, in turn, by means of the external current-reversing passages *m*, *m*¹ and shaft passages *f*. The casing *b* is divided into compartments for the wheels by partitions *k*, *g*.

6199. Internal-combustion engines. VOGT, A., 91, Thornlaw Road, West Norwood, Surrey. March 13.

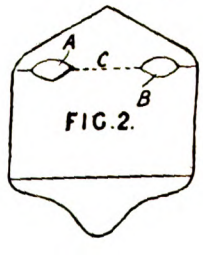


In Specification No. 23,122, A.D. 1901, engines are described with a combustion space which yields on explosion, so that the pressure does not rise much above that of compression. By this invention the motor piston, Fig. 1., or an auxiliary piston, Fig. 2, forms the yielding part. The space 14 between the parts 6 and 10 of the piston, Fig. 1, is charged with air, to form a cushion at starting, and the space 8 receives air from the pipe 7 on the end of the outstroke and compresses it through valves 11, 12 and pipes 16 to a reservoir, for starting. In the arrangement shown in Fig. 2, the space 18 forms the barrel of the air-pump, suction and discharge valves being placed side by side at 23.

6394. Explosive-vapour engines. BRUSH, A. P., 958, Hastings Street, Detroit, Michigan, U.S.A. March 15.



Carburetting.—Air drawn through the pipe *d* lifts a disc *i* on the needle valve *f* and with it the valve, allowing oil to escape from the pipe *e*. The valve slides on a rod *m*, and is closed by a spring *k* adjusted by the plug *j* and nut *n*.



6803. Envelopes. TYERMAN, F. W., 5, Chapel Street, Liverpool. March 20.

Two holes *A*, *B* connected by perforations *C* are made in the fold of one of the flaps. The envelope is opened by pulling the enclosure.

Prize Competition.

ONE of the principal objects of this journal being to encourage and foster the introduction and propagation of new ideas, the Proprietor offers a series of money prizes to those who, in his opinion, send in the best and most practical solutions to certain problems, which will be set each month.

The competitor gaining the greatest amount of marks each month will be awarded the monthly prize of ONE GUINEA. But in order to encourage clever inventors, and not merely reward those who may happen to hit upon a happy idea, a GRAND PRIZE OF **ONE HUNDRED POUNDS** will be awarded—after twelve problems have been sent—to that inventor who shall have gained the greatest aggregate of marks during that period, provided he shall have gained at least *30 per cent. of the full marks* in at least six of the competitions (whether he has gained a monthly prize or not).

RULES.

1. Designs to be sent in to the office before the end of the current month, accompanied by the coupon cut from this paper.
2. The solutions sent in must be concise, yet fully descriptive of the idea intended. To comply with this they must not exceed 300 words, and not more than two simple diagrams should accompany it.
3. Solutions will be published as considered desirable by the editor.
4. Competitors may obtain patent rights for their ideas, but they must run all risk of the publication in this paper interfering with the obtaining of such rights.
5. Competitors may send in their designs under a fancy name for publication, but their true names and addresses must be inserted on the coupon, which, in the event of their winning a prize, will be published. The same fancy name must be adhered to throughout in future.
6. The same person may send in two solutions so long as a separate coupon accompanies each. All marks so gained will count for the grand prize, but the monthly prize will only be awarded for the one best solution. If the two solutions appear to the judge to be but slight variations of the same invention, marks will be deducted from the second solution.
7. Novelty of design is not a *sina qua non* (since this would be extremely difficult to prove), but only the person sending a description with the coupon is entitled to reward.
8. It would add to the value if a statement be added to say if the design has been practically tried; but to corroborate this the inventor may be called upon to give a demonstration before receiving a prize.
9. In the event of an equality of marks or any other exceptional circumstances, the proprietor will decide on the fairest method of distributing the prize.
10. Non-compliance with the above rules may disqualify a competitor.

KASS No. 2 (**42**). Engine run by compressed air stored in steel cylinders, at pressure of 2,400 lbs. Passing through reducing valve at 300 lbs. per sq. in., it enters high pressure and low pressure cylinders. Small furnace of liquid fuel to maintain even temperature.

A. C. T. (**40**). Water-tube boiler fed by pipes from sea. Injectors deliver a stream of water astern and so propel the ship. *Simple if wasteful of fuel.*

KOH No. 1 (**37**). Air pumped into a reservoir on boat at landing place. This drives turbine or other engine. *Better utilize portable reservoirs to interchange.*

MEPHISTO No. 1 (**33**). Petrol engine in boat compresses air to drive engine to propel boat when required. The heat from the explosions is taken up by stream of mercury and imparted to the compressed air.

KOH No. 2 (**30**). Boat mounted on two buoyant rollers, or paddles, each connected to small engine. A rolling drum on the end of strong lever floats behind, and action of waves or ripple causes lever to work air pump to supply engines. *Ingenious, but wouldn't work if calm.*

KASS. No. 1 (**20**). Small engine running continuously drives dynamo to charge accumulators. When boat is required to go, current from accumulators switched on to motor driving propeller. *Somewhat complicated—dynamos and accumulators might be replaced with more powerful engine.*

MEPHISTO No. 2 (**20**). Water flows into chamber placed in bottom of boat, thereby raising a float. This compresses air. When float reaches top, valves acted on, and air forces float down, driving water along a pipe, whence, after passing air compression chamber, it issues as jet propeller. *If we understand the action correctly, the power obtained would be very small.*

The Monthly Prize of One Guinea has therefore been awarded to

"KASS."
W. Cassels Brown,
9, Manor Street,
Berkhamsted.

The Subject for next Month will be—

A DUST PREVENTER,

or device applied to a motor car to prevent, as far as possible, dust being raised in the track of the car.

COUPON.

To the Proprietor, ILLUSTRATED SCIENTIFIC NEWS.

I herewith forward my idea for a solution of the problem on "A Dust Preventer," according to the conditions published in your paper, and I agree to comply with those conditions.

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Address.....

.....

Fancy Name for publication.....

Date.....

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Scientific News.

A Monthly Journal devoted to Popular Science.

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British Association Memories.

BY SENEX.

Fructus senectutis est ante partorum Bonorum memoria et copia.

THE Editor appeals to me, as an age-stricken but not yet doting Struldbrug, to justify my presumptuous longevity by calling up from Acheron some amongst the illustrious dead whom I have seen and talked with in bygone years, and presenting them in their habit as they lived. Scientific ghosts of course they are to be, sharing Paradise let us hope to-day along with Dean Burgon's "sainted ancestors"; and it is suggested that I should group them by recalling some of those British Association meetings at which they were wont to gather annually for a crowded hour of their glorious lives; meetings where fun walked hand in hand with Science, affectionate réunions with sometimes fierce polemic controversy.

1832.

My memory of these goes back very far indeed; for I was in Oxford, a child with open eyes and ears, at the Meeting of 1832. The President, Dr. Buckland, was an intimate in my home, and brought thither many of his *confrères*; Frank Buckland and myself were boy naturalists and playmates; but though fair Science frowned not on our humble birth, she did not admit us to her palaces, and we were content to pick up crumbs from our elders' talk. Unsuspecting Oxford hospitably received the cuckoo's egg which was some day to make havoc in its nest; the Vice-Chancellor, old Collier Jones, the *Marilaides Ioneus* of a contemporary Greek squib, fed the lions at a public breakfast in his College Gardens under the shade of Reginald Heber's chestnut; the University stayed with flagons and comforted with apples the nightly conversaziones at the Clarendon; while fat bucks were daily carted in from Stowe and Nuneham. William Smith was there, the father of English geology, and handsome young Murchison, and Sedgwick glaring through owlish spectacles, and Owen, and Sir Charles Lyell, and clerically imposing Prebendary Vernon Harcourt; but Buckland was the life of the Meeting, gathering one day a great audience of foot and horse on the top of Shotover for an explanation of the local geology, on another expounding the newly discovered *megatherium* in a lecture which Owen called inspired, and Lyell declared to be the best which his volatile friend had ever been known to deliver. One aspect of the occasion was criticised not without acrimony amongst our elders. Ladies were not admitted to the reading of the Papers; the great Mrs. Somerville voluntarily declining to attend, lest her presence should bring others of her sex, and a serious conclave should degenerate into a frivolous picnic. The rule worked its own reform, and was cancelled in the following year.

1847.

Both Frank and myself had reached man's, or at any rate undergraduate's, estate, when in 1847 the Association again met in Oxford. At a garden party given by Daubeny in the beautiful Physic Garden, Frank exhibited his famous bear, Tiglathpileser, dressed in cap and gown, introducing him as a student of Christ Church to the foreign celebrities, who enjoyed the fun more heartily than did some of the Oxford Dons. Monckton Milnes came next morning to breakfast at Frank's queer rooms in Fell's Buildings, and succeeded in mesmerising Tig, who after much growling succumbed to his passes and fell asleep. The liberality of the University on this occasion was tinged with some hostility. In the year following on the last visit, the Bampton Lecturer, a certain Dr. Nolan, had vehemently renounced the Association and all its works. The cosmogony which puzzled Mr. Ephraim Jenkinson seemed in peril of dissolution under geological theories, and Buckland's Bridgwater Treatise had brought out the heresy hunters. Pusey protested against conferring a degree on Owen, but was disarmed by the tact and frankness of Henry Acland, and having come to curse remained to bless; it was through his influence four years later that the vote for the new Museum was carried against bitter opposition; and on this occasion, being absent from Oxford, he gave up his house for the entertainment of distinguished visitors. It was a fine meeting, admirably organised by Acland, who was local Secretary. Prince Napoleon of Canino was there, the guest of a half-crazy humourist, Newman of Magdalen, who showed me afterwards an eloquent appreciation of Oxford hospitality written by the Prince on the flyleaf of his Liddell and Scott. Bunsen, too, was there, with Milne Edwards and Van der Hoven; to the English scientists of the 1832 meeting were added Faraday, Edward Forbes, and Hooker; while Sir Thomas Acland, a Pertelote on the bank, watched with anxiety the eccentric Broad Street duckling who had made appearance among his own brood of tame villatic fowl. Perhaps, to those who knew, the most interesting man present was Robert Chambers, author as yet unavowed of the newly published "Vestiges of Creation," which at the time of its appearance caused more excitement than any book of the century, more even than the "Origin of Species." He read a paper on "Raised Beaches," and was rather roughly handled by De la Beche and Buckland in the discussion which followed. I remember writing a paper on his book, and sending it to several scientific journals. All showed their sanity by refusing it; for the virgin literary production of a very young man is, in medical language, an intellectual *meconium*.

1860.

The Oxford meeting of 1860 was historic on two accounts; it was the handselling of the New Museum, and it witnessed the duel between Wilberforce and Huxley. The beautiful interior never looked lovelier than under that July sun streaming softened through the glass roof into the central hall, lighting up the fine statues in all their newness, Shea's exquisite capitals, Skidmore's lifelike foliage of supporting chestnut boughs and leaves. The open space was strewn by day with chairs and tables, with microscopes by night. Young Oxford was there, in cap and gown, men of the future unknown then; P. L. Sclater, Pridgin Teale, J. H. Green, with Percival Wright from Dublin. I recall kindly white-bearded Westwood dropping his aspirates to English visitors, discoursing German and French to foreigners; Bowerbank, with his olive face, haranguing a group of young microscopists on the merits of the achromatic condenser; old Rowell showing the Great Auk's egg, and challenging ladies to pass a knife between the two great magnets; jolly Lankester, in white hat and ruddy countenance, chaffed by knots of juniors, and exhibiting proof engravings of the latest Ray Society monogram; and Brodie, and Beale, and Rolleston, and modest Charlie Robertson—*fortemque Gyan fortemque Cloanthum*. All these hold a back place in memory; in the foreground is the famous duel —the two famous duels; for to the cause of science Owen's attack

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on Darwin was far more serious than that of Wilberforce, who merely dressed up Owen's arguments with rhetorical dexterity and an infusion of theological bitterness. Owen's presence had drawn a full meeting to Section D, where Daubeny was solving by Darwin's hypothesis problems as to the sexuality of plants. Owen, who was not a botanist, flouted Darwin's theory, going directly to the Simian relationship of Man, and basing a fundamental difference between Man and Ape on the absence from the latter of the structure which Kingsley afterwards comedised as *Hippopotamus major*. Huxley, in a few curt words, declared Owen to be absolutely wrong, and pledged himself to prove his contradiction in detail elsewhere. Owen *was* wrong, as is now well known, and by persisting in his error against evidence brought pain to his friends and mortification on himself. He was a guest at Cuddesdon, coaching Wilberforce for an Article on Darwin which appeared in the ensuing *Quarterly Review*; and it was rumoured next day that on the Saturday, when Dr. Draper, of New York, was to read a Darwin Paper, the Bishop would be devil's advocate and avenge Owen's discomfiture. The whole scene is before me as if of yesterday; our meeting in the lecture room, speedily found inadequate; our rush to the as yet unfurnished library, soon in its turn crammed; Henslow in the chair, with rough unclerical exterior; Draper, nasal and tedious; old Dicky Greswell, rising and falling on his toes to aver that we had not since Homer's time developed. Then the Bishop's speech; silvery, humorous, adroit, as of a well-primed, practised advocate, speaking of things which he knew only at second hand to people who knew them not at all, but who would take them as gospel from his lips; until he struck the fatally false note—false because at once hackneyed and in bad taste—of the grandmother ape. Huxley's answer, after a few uneasy sentences, was crushing in argument, perfect in tone and temper, without the literary grace which he afterwards acquired; his famous retort, which no two men of those who heard him have succeeded in reporting quite alike, was deserved by Wilberforce, and made his answer perhaps more effective with the audience than if he had refrained from emulating the Bishop's coarseness. Win them he certainly did; they cheered him when he sat down almost as rapturously as they had cheered his opponent, whose inscient devotees, fain to believe that their Bishop had carried off the palm, went away uneasily apprehensive that his superiority, if such it were, would be discounted as a Pyrrhic victory.

1869.

In 1869 I found Huxley dominating the Association at Exeter, which formed a sort of sequel to the Oxford meeting. During those nine years much water had flowed under London Bridge. Philistia had learned that Darwin was come to stay, and that scientific theories must be judged on scientific, not on Scriptural, grounds. A Scottish Doctor of Divinity, as he took care to tell us, revived the old controversy by a formal attack on the "Origin," in pompous language and with vehement gesticulation. I could not press into the crowded room, but perched on a sort of pedestal attached to the entrance. Sir John Lubbock, perceiving me aloft, elevated himself to a similar coign of vantage on the other side—"You looked," said a lady from within, "like a couple of Caryatides." Huxley's answer to the Scotchman was the most perfect utterance I ever heard from his lips; a gem of literary finish, with lucid argument, ornate quotation, from time to time lashing his arrogant victim *sublimi flagello*, amid the passionate cheers and laughter of the audience. "You mangled him almost too severely," I said to him afterwards, for in these years I had come to know him well. "No," he said, "the man was saucy." Next day he spoke again in answer to a Canon or Archdeacon Freeman, who read a paper on the "Genesis of the Cherubim." A ludicrous affair it was—wicked Newton called it a new science of Cherrybumology; and when Huxley rose people looked for fun. Nothing of the kind. He saw the man to be sincere, unaffected, modest, producing his queer speculation in serious earnest and good faith, and handled him with condescending kindness in a truly generous spirit. Of other events, I recall how in Section F, Sir John Bowring, emitting some confused dogma as to the London Clearing House, was pulverised by Lubbock; and how Miss Lydia Bekker, pioneer of the Woman's Movement, projected her lean face and showy bonnet into every discussion. To one surprising statement made by her, I think on the inflorescence of the Cruciferæ, Balfour in the chair answered, sarcastic and severe, that no botanist had ever noticed the phenomenon. Her rejoinder, "But why shouldn't I be the first to notice it," tickled the audience and silenced the Professor. I was Lubbock's guest at the Red Lion dinner, where Wisdom each year avowedly plays the fool as only cleverness can do, and remember the boisterous fun of the tail-wagging, roaring lions. Lord Houghton was in the chair; the Cathedral bells rang out while he was speaking. 'Stop those bells," he cried to the grey-haired, deferential head waiter, who started instinctively to obey, then collapsed, half-amused and half-resentful. Edward Forbes was there; and Pengelly recited a geological parody on Gray's Elegy; Lubbock made the amusing speech of the evening; and Clifford, in a wonderful short oration, described a mathematician's dream.

1871.

Two years later, in 1871, I joined the Association at Edinburgh. By this time, Darwin controversy was dead and comfortably cremated; yet, even in its ashes, lived its wonted fire. My wife reminds me that as we travelled up, a lady, seeing in me, I suppose, a budge doctor of the Stoic fur, asked if I were to read a paper. I admitted it. "Oh, then, I do hope you will put down Darwin." "Why?" "Oh, because he is such an idiot." "If he is an idiot he does not need putting down," appears to have been my replication. The Scotchmen were, of course, very much in evidence; Sir William Thomson was President; Dr. Donaldson, of the High School, harangued us on Secondary Education; good-looking Archibald Geikie roamed about; and Sir Alexander Grant, with his charming wife, niece to the novelist Miss Ferrier, welcomed us to a conversazione at the University. There, too, was Rain-gauge Symons; and E. B. Tylor, who delivered the Evening Lecture handicapped by a severe cold; and Prestwich, and Colonel Lane Fox, and dear Joshua Fitch, who died but yesterday, and young Norman Lockyer, who "thought himself owner of half the Corona," said the wags, and Bonney, ferociously eager to trample on the parsons—I believe he is reconciled to them now—and Coroner Lankester, who delighted us in one of the sections by addressing the President as "Mr. Foreman." We gave unwonted liveliness to the sombre Sunday streets of the unco guid city; some went to hear old Dean Ramsay at St. John's Chapel—he was too ill to appear, and his sermon was read by a curate, the fiddle but not the bow—others to the Tron church, the preacher Dr. McGregor. When he entered the pulpit I asked his name of an austere Manse Headrigg who sate beside me; but "mind the psaum" was the only answer I received.

1886.

One last reminiscence—it shall be the last—takes me to the Birmingham Meeting of 1886. A few older men were there; Canadian Dawson, last surviving champion of a spurious *Eozoon* and of discredited reconcilist theories; and cheery Dr. Woodward from South Kensington; and gentle, pious John Hall Gladstone; and Tangye, prince of machinists; and botanic Oliver; and Winwood of the Bath oolite. Mason's College sent forth its brilliant juniors, Lapworth, and Hillhouse, and Tilden; while young Rücker made soap bubbles fascinating by his exquisite lantern slides, and Boyd Dawkins showed a flint flake of human manufacture, disinterred from beneath the earliest glacial clay in the Vale of Clwyd. A special feature of the meeting was the Great Exhibition in the Bingley Hall, representing in completed products or in constructive machinery the more than two hundred industries, passing from what was then the workshop of the world into every quarter of the globe. Here Schiller's poem found illustration in the casting of a huge bell; there with no poetic associations Britannia metal was manipulated into teapots; or the Edgbaston blind workers minimised loss of sight by dexterous chair-seating, brush-making, basket-weaving; or seventeen small machines worked by the same number of girls in pretty cotton uniform went to the making of a watch. A street of sixteenth century Birmingham reared its lofty timbered gabled houses along one side of the great hall. In a chemist's shop, hung with alligators, monkeys, mandrakes, two black-robed and white-bearded alchemists handled crucibles and poured elixirs; beneath a sign of Olde Father Tyme workmen in the costume of douce David Ramsay and his apprentices fashioned primitive clocks; in Ye Olde Crowne refreshments were sold by a portly host with the aid of comely maids in caps and wimples. A Baskerville chamber was filled with the types, the books, the broad sheets of the great Birmingham typographer; in a Watt and Boulton room were models of their earliest steam engines with original letters of the partners.

Scientifically, the meeting was pronounced somewhat dull. So I thought, not without suspicion that the fault was in myself. I read a Paper in one section, and joined freely in discussion at another; but the Association itself, which I had not attended for several years, seemed to have gathered an autumnal shade. The veterans of earlier gatherings had passed away, and the young men did not to my fancy fill the gap. I sat one night with old Pengelly in a corner of the Art Gallery, and we murmured over Moore's tear-compelling lines, and hymned the praises of the past, recalling vanished heroes and their fame. We tried to console ourselves with Homer's adage: if dead leaves lie upon the soil, young leaves beautify the branches: yet remembered sadly that we should soon be among the first, and that while young leaves bourgeon and flutter and enjoy the air they breathe, the old leaves are cast into the oven. So we ended, as I will end to-day, by turning from the personalities of the Association to its time-honoured record and enduring services, justifying the aspiration of its founder David Brewster, that he would "build a craft wherein the united crew of British Science might sail." It has, as he hoped, *unified* Science, bringing together annually scattered students and discoverers who must have otherwise failed in mutual touch and acquaintance with each other's progress. It has *popularised* Science, filtering down each year amongst its half-educated visitors fresh knowledge of annexed Nature realms: and, herein, with consequences yet more lasting, it has habituated the public mind to preference of reason over dogma, of truth over prepossession, teaching it in Shakespeare's words, that "ignorance is the curse of God, knowledge the wing wherewith we fly to heaven." So now I stand aside and wish it well; and read each year from my retirement the chronicle of its assembling, its excursions, its addresses and debates, not without contrasting memories of its past, not without cordial benedictions on its future.

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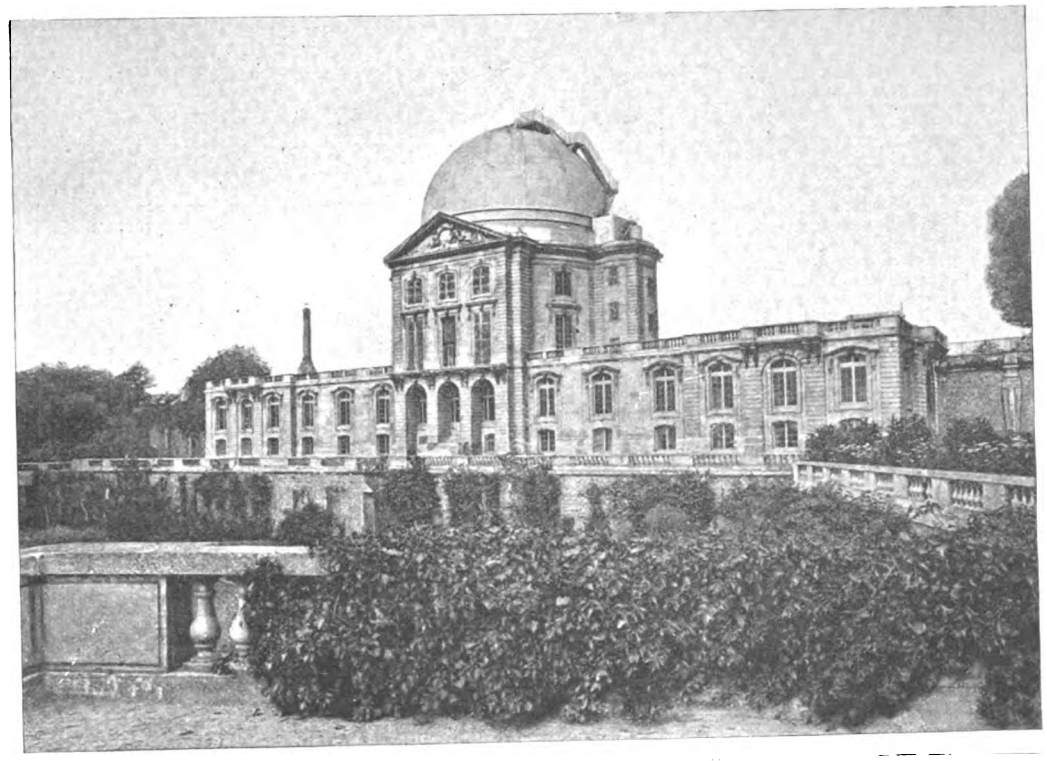
Solar Physics Observatory at Meudon.

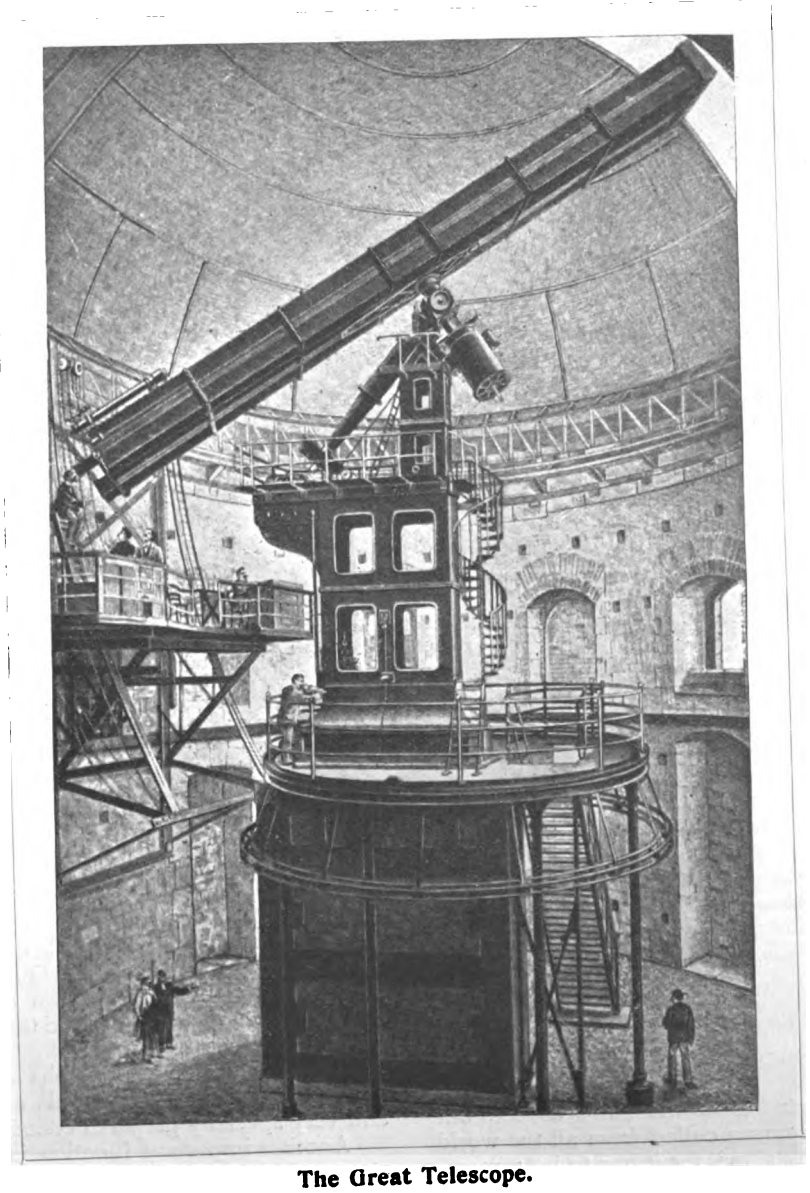
THE Park at Meudon, situated on the top of a beautiful wooded hill overlooking Paris, the Bois de Boulogne, and the valley of the Seine, has passed through strange vicissitudes and has witnessed many distressing scenes. No less than three successive royal palaces have stood within these grounds, each in turn to fall a prey to war or revolution. The last of these palaces was burnt by the Germans on leaving Paris after the siege, and M. Janssen, the first and present Director of the Observatory, on once receiving a distinguished German visitor, expressed his gratitude to Germany for having provided a ruin on so favourable a spot, which useless incumbrance the Government were only too glad to convert into an Observatory at M. Janssen's earnest request.



The Observatory.

After the war the fine old chateau stood gaunt and bare, windowless, and with tottering walls, perched on the high terrace visible from afar, and forming a feature of the landscape. There it remained for years, a monument to war! Then, in 1875, Science claimed her share. A credit of £44,000 was obtained, the chateau was rebuilt, and converted into the spacious Observatory which now occupies this historic site. The former ball-room was surmounted with a huge cupola, nearly 60 feet in diameter, in which was installed one of the biggest telescopes in the world.

This great refractor has an aperture of 32½ inches, and is only exceeded in size by those at the Yerkes and the Lick Observatories (40 and 36 inches respectively), and that made for the Paris Exhibition of 1900. Two telescopes are mounted together, the large one having beside it a photographic refractor of 24·4 inches. The main tube is composed of steel, of rectangular section, and is over 50 feet long.



The Great Telescope.

The movement of the cupola and the platform is effected by electricity, so that by the mere pressing of a button, so to speak, the huge structures are slowly set in motion.

In various other parts of the grounds are minor observatories with their special instruments. Two are built with cupolas similar to that of the main observatory, but only 25 feet in diameter. One of these contains a large Newtonian reflector having a speculum of one metre diameter, which possesses many advantages as a photographic instrument. The other encloses a refracting equatorial specially constructed for solar photography. There are two other smaller telescopes and several instruments for magnetic observations housed round about

The control of this important establishment was placed in the hands of M. J. Janssen, who had long been known as an astronomer of the first water. He had specially interested himself in solar astronomy, and had made himself famous by disregarding the Prussian shells and escaping from besieged Paris in a balloon in order to get to a more southerly point from which to observe the eclipse of

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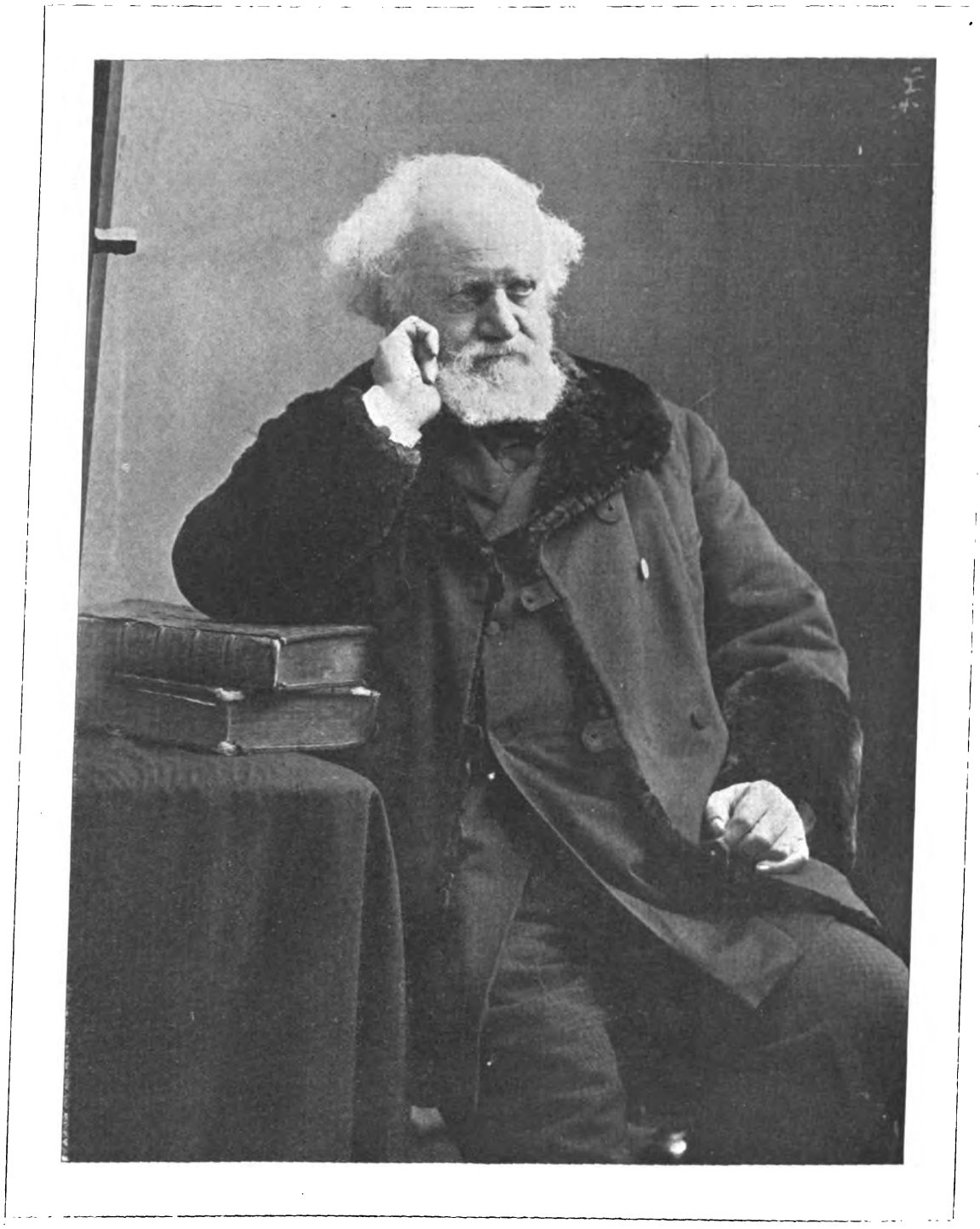
the sun in 1870. It was two years before this that he had hit upon a means by which the prominences at the edge of the sun, hitherto only visible during total eclipses, could be seen at any time. This is accomplished by diffusing the glare caused by atmospheric defraction by means of prisms. The idea occurred to the astronomer while actually watching an eclipse, and by early next morning he had constructed an instrument efficient enough to prove its value. But about the same time another great astronomer, Sir Norman Lockyer, this year's President of the British Association, discovered an exactly similar method, and the two reports being brought before the Academy of Sciences at the same meeting, a medal was struck to commemorate the event, with the profiles of the two discoverers together.

The chief object and *raison d'être* of this observatory, then, is the study of solar physics, a subject which Janssen has brought so much to the fore. It is one which may prove to be of the greatest importance from a practical point of view, since there seems to be some connection between sun-spots and solar disturbances and the climate of this earth. At all events many observers believe that magnetic disturbances are coincident with sun-spot periods, though it must be added that, during the last few weeks, Father Cortie has brought forward strong arguments to oppose the theory. If it could be proved that these solar eruptions did have any effect on the meteorological conditions on the earth, it might be a matter of supreme interest and importance to mankind, for droughts might then be foreseen, storms predicted, and other effects foretold and provided against.

But before any definite conclusions can be arrived at on this point a vast amount of careful records have to be compiled. Not only is it necessary to make prolonged studies of the sun's aspect, but statistics of all meteorological phenomena culled from all the world over must be collected and carefully sifted, for it has to be remembered that all local effects must be eliminated, and the daily climate of the whole world alone considered. Variations in the solar photosphere cannot well affect one particular spot on our little planet. Thus, though the sun's face can be examined from any point on the earth, the possible terrestrial results of his changes can only be ascertained by gathering reports from many widespread points on the earth's surface.

The first great object, then, of this observatory is to obtain daily, or as frequently as possible, photographs of the sun's surface. These are taken in one of the great telescopes, the exposure being but one three-thousandth to one hundred-thousandth part of a second. They are then carefully enlarged to one scale to make a complete map, and are then placed in an atlas. Over 4,000 photographs have been thus arranged. The specimen reproduced herewith will give an idea of the great amount of detail that may be got from a careful study of this atlas. Here are to be seen a fine group of sun-spots, but, of course, these are often, indeed generally, absent, and the plain and more or less evenly mottled surface is all that can be studied.



M. J. JANSSEN.

But even this has considerable interest. The bright granules stand out from the darker surface, and these are supposed to be the more intensely heated columns of incandescent gas rising to a higher elevation than the surrounding portions. It has been calculated that if the whole sun were as bright as these points it would be from 10 to 20 times more brilliant. The sun-spots are usually surrounded by bright margins, which leads one to believe that the edges are elevated, giving support to the theory that they are of the nature of volcanic outbursts.

These beautiful photographs are the outcome of much study and experiment. Optical materials of the finest quality are required, and very specially prepared collodion plates used.

Another important function is the photographing of spectra of stars and planets. By ascertaining in this way the composition of these bodies, and especially investigating the gaseous surroundings

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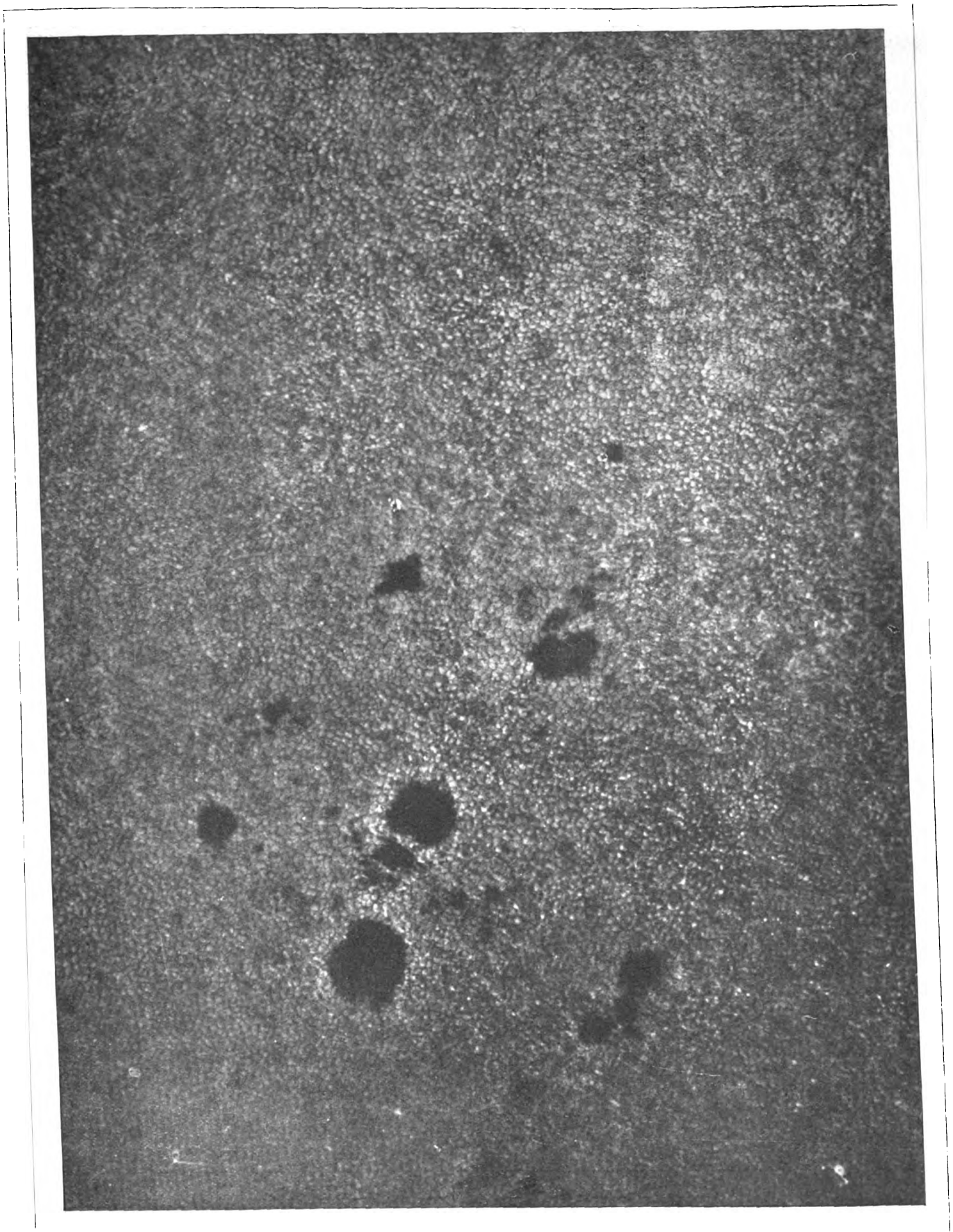
of the planets, we may be better enabled to surmise on the possibility of their being inhabited by beings of a similar nature to ourselves. We are, as M. Janssen puts it, but as little insects on the leaf of a huge tree, and we know not whether the other myriads of leaves are capable of sustaining life in a similar manner. This, he says, brings us to a true notion of the Divinity.

In order to carry out this work in a complete manner, and to make a careful study of spectroscopic analysis, a laboratory has been established in connection with the observatory. This is situated in the old stables, which were thoroughly renovated by Prince Jerome Napoleon, and form most suitable premises for the purpose, being over 100 yards in length. Along the old stalls, which are very solidly built, are ranged long tubes with glass-covered ends, to contain various gases under pressure. At one end a dark room, or rather a huge camera, is arranged, while at the other end of the tubes a brilliant light is exposed, which, penetrating this length of any particular gas, throws the spectrum on to the photographic screen.

A long covered-in trough is fixed up in one part to contain water. Beneath this runs a series of jets, so that steam can be produced along the whole length. Windows of quartz, to withstand the great heat, at each end enable observations to be made. There are also means of determining the spectra of gases at a very high temperature. In this laboratory is a wonderful balance, enclosed in a glass case, capable of weighing anything from 40 kilogrammes to ·01 gramme. This is used to determine the density of compressed gases, the employment of manometers being considered unsatisfactory. By weighing a small steel tube full of compressed gas, and then opening the cock, the exact weight of the gas can be obtained.



Photograph of the Sun's Surface.

(The entire disc of the Sun on the same scale would be 35 inches diameter.)

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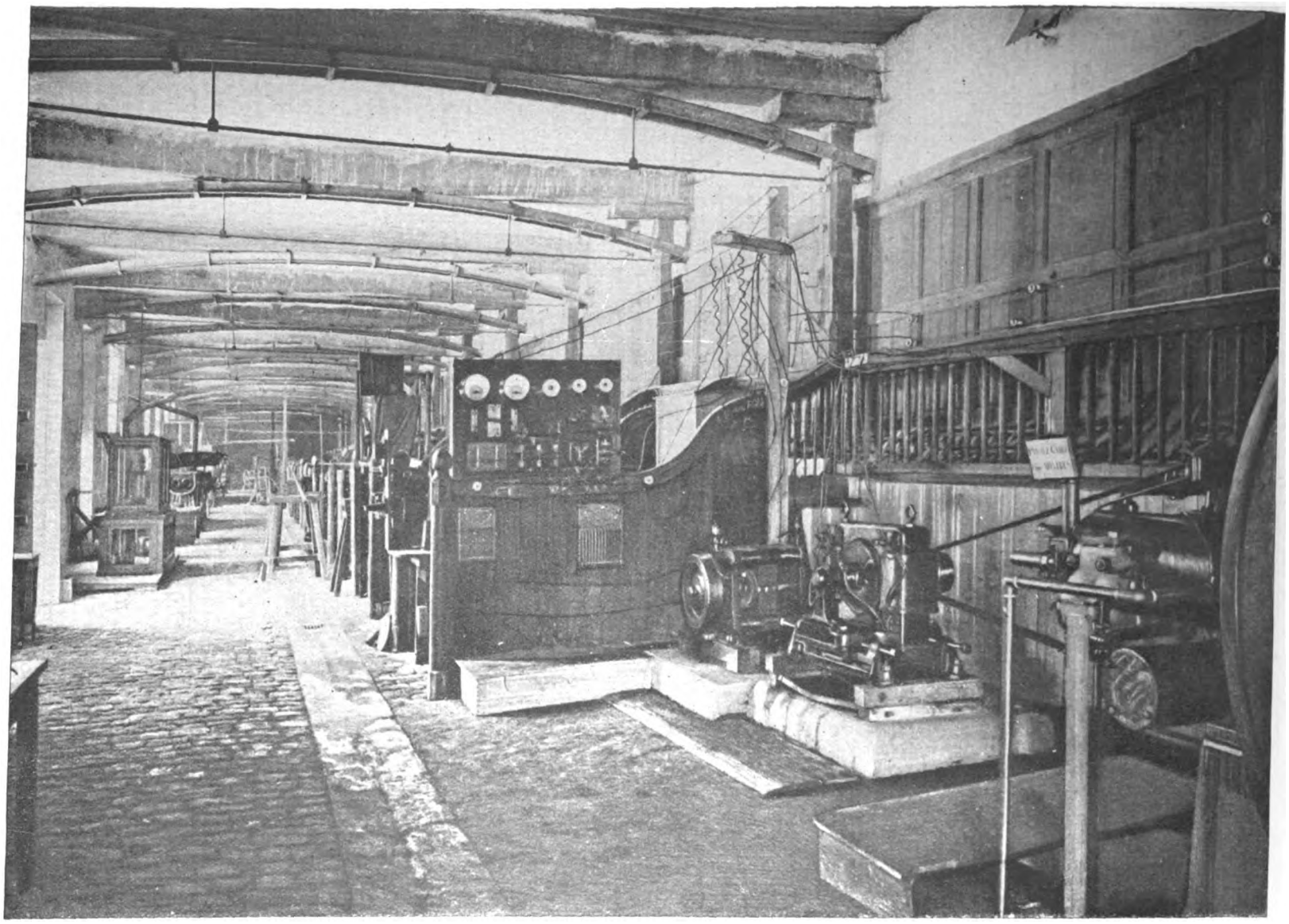

The Laboratory in the Old Stables.

The establishment is completed by the addition of some buildings adjoining the stables, wherein is an extensive library, offices, and the residences of the astronomers and assistants.

Astronomical Notes for September.

THE SUN.

On the 1st the Sun rises at 5 h. 12 m. a.m., and sets at 6 h. 48 m. p.m., the length of the day being therefore 13 h. 36 m. On the 15th he will rise at 5 h. 35 m. a.m., and set at 6 h. 17 m. p.m., the length of the day being then 12 h. 42 m.

A total eclipse of the Sun occurs on the 21st, but as the line of totality will be entirely confined to the Antarctic Regions, the mere mention of this phenomenon will suffice.

On the 24th, the Sun is said to enter the *sign* Libra, and Autumn commences at 5 h. 44 m. a.m.

Sunspots may be expected to be fairly numerous in this month.

THE MOON.

Our satellite will be full on the 7th, at 0 h. 20 m. a.m. ; attain her last quarter on the 14th, at 1 h. 14 m. p.m.; become new on the 21st, at 4 h. 31 m. a.m.; and reach her first quarter on the 28th, at 1 h. 9 m. p.m. She will be in apogee on the 3rd, in perigee on the 19th, and in apogee for a second time on the 30th.

The September Moon is popularly known as the "Harvest Moon," inasmuch as at this season of the year the apparent path of our satellite makes the least angle with the horizon at the time of rising, and therefore rises but a very short time later on each succeeding evening after becoming full, and hence was deemed of use to give light to the harvesters ; but modern methods have rather upset this idea, except in the case of abnormal seasons.

Occultations will take place (1) on the 13th, when B.A.C. 1526 (magnitude 5·8) will be occulted by the Moon at 11 h. 56 m. p.m., at 61° from the true north point, and reappear at 0 h. 52 m. a.m. (on the 14th) at 279° from the T.N.P.; and (2) on the 18th, when α Cancri (mag. 4·3) will *reappear* at 2 h. 36 m. a.m., at 247° from the T.N.P., the *disappearance* being *invisible* at Greenwich, owing to the star being below the horizon.

The Moon will be in *conjunction* with Saturn on the 3rd, Jupiter on the 7th, Venus on the 20th, Mercury on the 22nd, and Mars on the 25th.

THE PLANETS.

Mercury is still said to be an "evening star," and will be at his *greatest elongation east* (27°) on the 7th, but is now very unfavourably situated for observation.

Venus will be too near the Sun for observation during the early part of the month, being in *inferior conjunction* with that luminary on the 17th. Towards the end of the month, however, she may be observed as a "morning star" in the south-east, rising on the 28th at 4 h. 43 m. a.m., with an apparent disc 56″·8 in diameter.

Mars continues to be an "evening star," but is very poorly placed for observation, being low down in the south-west.

Jupiter comes into *opposition* with the Sun on the 12th, at 6 h. a.m., and will prove a splendid object during the whole of the month, rising at 6 h. 31 m. p.m. in the south-east on the 10th, and at 5 h. 33 m. p.m. on the 24th. On the 18th his R.A. will be 23 h. 16 m. 22 s., and his S.D. 6° 22′, the apparent diameter of his disc having increased to 45″·8. To the possessor of a good telescope Jupiter will prove an even more interesting object than usual this year as, apart from the usual phenomena of his satellites and belts, some markings of a novel description have been already noted by the regular Jovian observers.

An early opportunity should be seized to make the most of the present apparition of Saturn, as he now rapidly declines—in both declination and apparent diameter, the former having reached 20° 12′ S. by the 28th, and the latter being only about 16″. The planet rises in the south-east at 5 h. 21 m. p.m. on the 3rd. On the 18th he will *south* as early as 8 h. 35 m. p.m. Curious markings have also been observed on this planet.

On the 28th Uranus sets at 8 h. 51 m. p.m., with an apparent diameter of 3″·5. He will be in *quadrature* on the 15th, and will be close to 44 Ophiuchi on the 1st, when he will be *stationary*.

Neptune will be found almost exactly between μ and ν Geminorum. On the 28th he will rise at 9 h. 51 m. p.m., with N.D. 22° 15′, and R.A. 6 h. 25 m. 34 s.

THE CONSTELLATIONS.

The stars of September are the least interesting of the whole year, the constellations above the horizon in the evening hours being for the most part small and inconspicuous. At 10 p.m. about the commencement of the month Capricornus (or the "Sea Goat") will be on the meridian, near the horizon, whilst slightly to the eastward, and lower still, lies Pisces, another constellation of the zodiac. Above these, Equuleus (the Little Horse) will be found. Cygnus is at the zenith, or right overhead ; whilst Lyra follows Ophiuchus and Serpens towards the Western Horizon. Turning Northwards, we see the Great Bear low down on the horizon, with the Lesser Bear just above him, whilst further to the eastward Perseus, Andromeda, and Cassiopeia form the usual rather interesting conformation. On evenings about the 20th, soon after sunset, an interesting bright star-cluster in Capricornus may be observed with very slight optical aid. It is situated in R.A. 21 h. 35 m. and S.D. 23° 35′.

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Singing Flames and Electric Discharges.

OUR readers will no doubt remember Duddell's experiments; the "singing" electric arc, designed by this physicist, is being put to interesting applications, in connection with Ruhmer's experiments in wireless telephony. It will, therefore, be of some interest to draw attention to Prof. A. Righi's researches, where sonorous phenomena, quite analogous, though due to another cause, were produced.

As may be seen from Fig. 1, for which we are indebted to the *Nuovo Cimento*, the electric arc as used by Duddell has been replaced by an exhausted air tube G with aluminium electrodes, a telephone T being inserted, along with a condenser C, in the derived circuit M C N. The main circuit includes a battery of 400 small accumulators, represented in B and giving with the high resistance R, constituted by tubes containing a copper sulphate solution, a current of some milliamperes, measured by the milliampere-metre A.

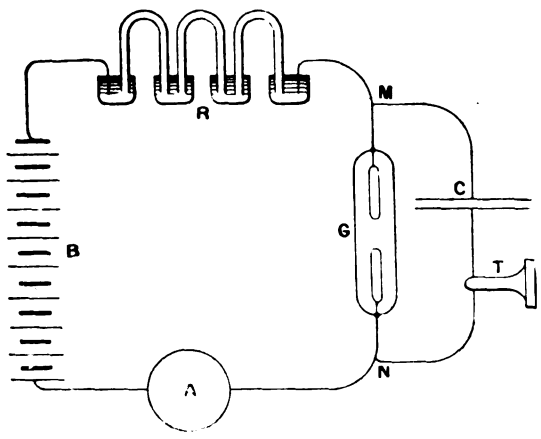

Fig. 1.

The exhausted air tube G contains two cylindrical electrodes with round terminals, one being fixed, whereas the other, by means of slight shocks, may be placed at variable distances from the former; for a pressure in the tube as high as one centimetre, a distance of 0.05 m. has proved most convenient.

Now, if first the derived circuit, and afterwards the accumulator circuit, are completed, a musical sound of a pitch variable according to circumstances will be produced, the luminous phenomena, as known in connection with Geissler tubes, being observed at the same time. The telephone, though not being essential, serves to enforce the acoustic effects.

The pitch of the sound, as above stated, depends on various circumstances, the note rising 1° as the resistance R is diminished, 2° as the number of accumulators is increased, and either the capacity of the condenser, or the mutual distance of the electrodes, or, finally, the pressure in the tube, is lowered.

A succession of musical sounds may be obtained and a novel musical instrument constituted, if, after having disconnected from the battery one of the conductors, now one and then another of the elements the battery is made up of are touched with the same.

Similar phenomena may be produced by replacing the tube G by the flame of a Bunsen burner. This attachment had already been used by Herr Ruhmer, in place of the electric arc, in connection with Prof. Simon's "speaking arc."

A Novel Scheme for Wireless Telegraphy.

WHEREAS the progress lately obtained in the field of wireless telegraphy tends mainly toward augmenting the limiting distances for telegraphic transmissions, the phenomena occurring in the medium separating the two stations have but scarcely been investigated, though similar researches would possibly give a means of obviating the numerous drawbacks as attendant on all of the actual systems. Among the difficulties preventing wireless telegraphy from being universally adopted, there is, in the first place, the impossibility of keeping such despatches private, as the telegrams are propagated from the sending stations in all directions. On the other hand, as the receiving stations will record telegrams emanating from any directions, they are exposed to external interference, rendering a correspondence between two given stations impossible. We may finally mention the impossibility of ascertaining the direction of origin for all the arriving telegrams.

All these drawbacks are, in the first place, due to the use of *antennae*. Now, Mr. R. Blochmann has presented before the Carlsbad Congress of German Naturalists, a modification of the actual systems. The *antennae* are replaced by another device enforcing electric rays and eliminating all the above drawbacks. Lenses of glass, paraffin, or any other substance with high dielectric constants proved especially available for the application in question. The dimensions of these lenses must not necessarily be great as compared with the employed wave lengths. The author has succeeded in covering by means of lenses 80 cm. in diameter and waves of a length of about 20 cm. distances as high as several kilometres. The electric waves emanating from the sending apparatus T (Fig. 1), can leave the apparatus only through the lense L. They are thus concentrated and orientated in a certain direction.

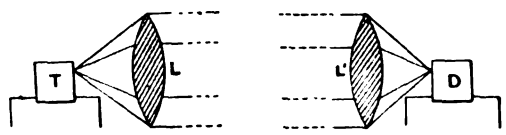

Fig. 1.

The effect of wave sets thus orientated is further enforced by traversing a similar lense L1 before striking the detector D placed at the receiving station in the focus of this lense. Outside of this action the waves are propagated in straight line between the two stations as are light waves emanating from an optical projector. As the property of these two kinds of waves are wholly similar, the author suggests terming this system of space telegraphy *ray telegraphy*.

By arranging at convenient intervals relay stations communicating automatically the arriving despatches to another transmitting apparatus, the limiting distance may be increased at will. Moreover, the system allows of installing beyond or around a chain of mountains a secret telegraphic service free from any possibility of interference. In some special cases—*e.g.*, if telegrams should be transmitted directly over great distances—the scheme may be completed by removable *antennae*.

When providing the receiving station with several detectors instead of one, the direction of origin of the arriving despatches may easily be ascertained, an electric image of the surrounding country being thus formed. In fact, in order to be perceived by the detector, the incident rays should be approximately paralleled to the common optical axis of the two corresponding lenses.

Ray telegraphy, *e.g.*, gives the means of ascertaining the position of a ship at any given moment, even during strong fogs, provided the ship is within the province of two telegraphic stations.

A. G.

A Paradox.

A CORRESPONDENT sends us an ingenious puzzle, which, if not new, is, perhaps, not sufficiently well known. A square piece of paper is ruled with lines to divide it, chessboard-like, into 64 squares. It is then cut

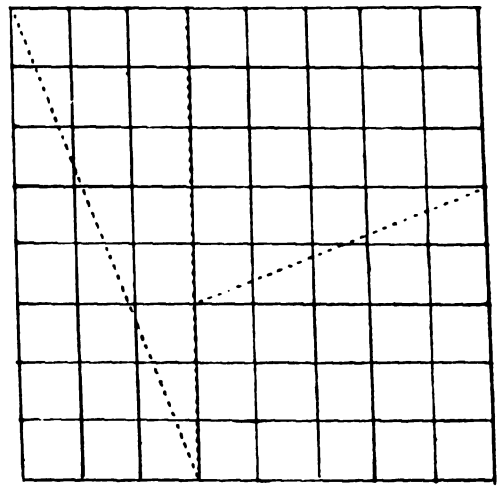

Fig. 1.

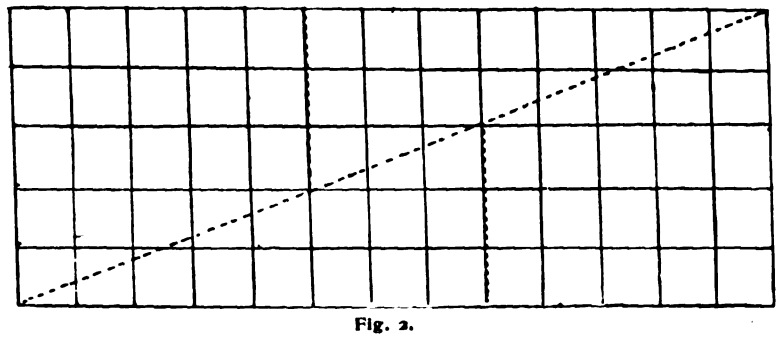

Fig. 2.

into four pieces as shown by the three dotted lines. The pieces are then laid as in Fig. 2, when it will be seen that there are now 65 squares! Whence comes the extra square?

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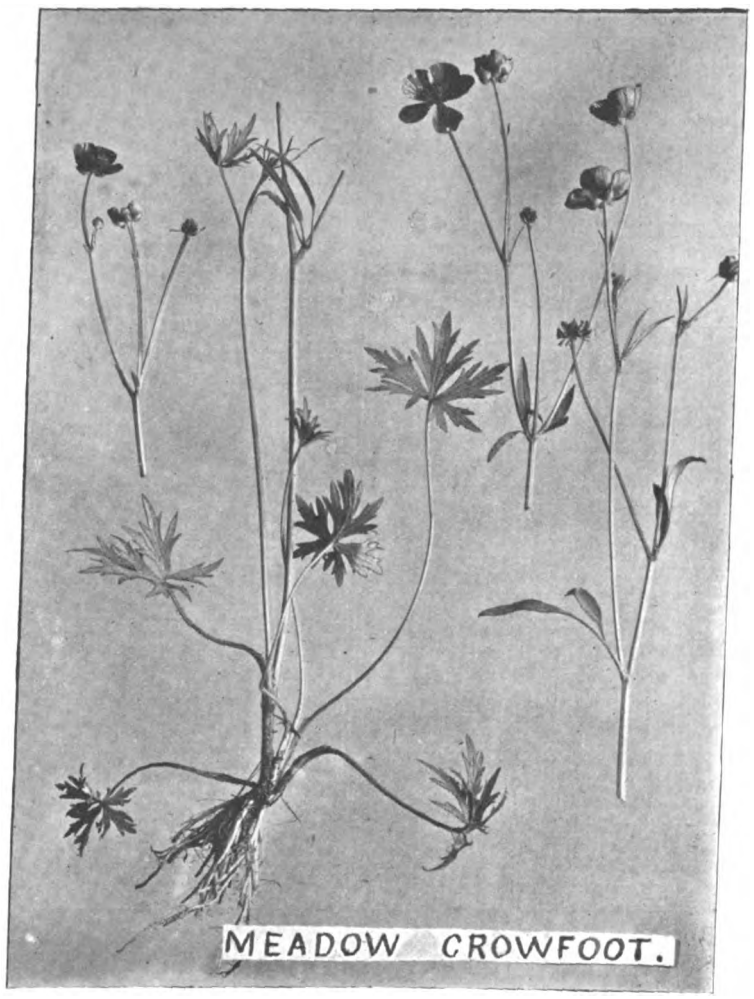
The Natural History of British Wild Plants.

By J. C. SHENSTONE, F.L.S.

PLANTS first interested men for their value as food and medicine. The writers of our early herbals, those of the sixteenth century and earlier, described and pictured plants solely with a view to their recognition as ingredients in medicine.

In time, however, it became apparent that many plants could be arranged in groups, the members of which had points of resemblance to one another, hence in the seventeenth century we find botanists attempting a systematic treatment of the subject, and early in the eighteenth century Linneus laid the foundation of the science of botany by establishing a system for the classification of plants, which though artificial, prepared the way for our present natural system, under which the species having natural affinities are grouped together.

During the seventeenth century students had investigated the anatomy and physiology of plants, and it was towards the end of the century that Konrad Sprengel made his series of splendid discoveries of the relation of flowers to the insect world.



It was not, however, until the nineteenth century that any serious advance was made in the science of botany, when a brilliant period of scientific research culminated in the work of Charles Darwin, which for a time gave a great stimulus to the study of plant nature.

Upon referring to the titles of books in botanical libraries, one finds works designed for the identification of plants, text books upon the physiology and morphology of plants, monographs upon the fertilization of flowers, and upon leaves, fruit, and similar subjects, but no attempt appears to have been made to focus all these branches of research upon our British wild flowers, and to furnish a complete "Natural History of British Wild Plants."

Such a work would bring the wealth of research, by half a century of botanical workers, within the reach of many nature lovers who live away from libraries. It would show how the natural affinities of plants extend through their complete life history, and would suggest starting points for fresh investigations.

The editor having offered me space for a series of articles upon the more important groups which compose the British flora, I will attempt to introduce the readers of the *Illustrated Scientific News* to the wealth of interest connected with our wild flowers. It will not be possible to deal exhaustively with so wide a subject, but I hope, at least, to stimulate some to a desire for further enquiry, by selecting typical groups and dealing with them as completely as space permits.

I do not intend in writing upon these groups or families to follow the order in which they appear in our floras, but commencing with the familiar and typical plants of the groups, pass on to those which appear to vary most from the normal type. Nor is it my intention to give the botanical characters by which the groups are defined and species identified, for such information the reader must refer to any of our descriptive floras. The individuals composing these groups usually bear such marked resemblance to one another, that students very soon learn where to place most of them in the natural system without specially looking for the characters by which the families are defined.

The first group of plants in the British flora is the

Crowfoot or Buttercup Family.

and probably the most familiar and typical plant of the crowfoot family is the

Meadow Crowfoot or Buttercup. (*Ranunculus Acris, Lin.*)

There are three distinct species of buttercup which paint our meadow landscapes in early summer with a flood of golden colour, thought by some to be unrivalled for beauty in any part of the world.

"And Lady's smocks all silver white,
"And Cuckoo buds of yellow hue
"Do paint our meadows with delight."
(Loves Labour Lost, 5, 2, 904.)

The meadow Crowfoot, which I propose first to write upon, has erect stems, sometimes two or three feet high. The creeping buttercup is most easily distinguished by its sending out creeping stems from the

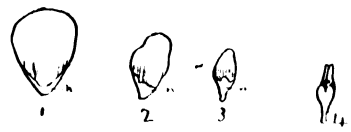
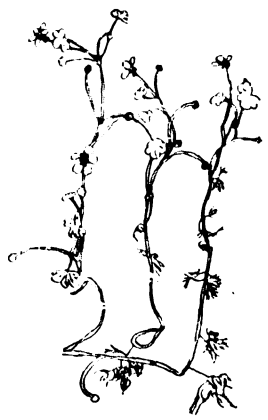


Fig. 1.—1 to 3, Petals of Goldilocks. n Nectaries. 4. Petal of Winter Aconite.

root-stock, and the bulbous crowfoot, another common plant in our meadows, may at once be distinguished by its having a bulbous swelling at the base of its stem.

It is not always easy to identify the plants intended by the names given to them by the early writers, or used by country folk even in the present day. The buttercup has had at least eighteen popular names. It is evident that Shakespeare referred to our buttercups by the name cuckoo buds in the above lines, whilst a plant now called ragged robin, and another known as the wild hyacinth, were in Shakespeare's day called crow-flowers.

The name buttercup is thought to have been a corruption of button cup, and is connected with the fancy that buttercups colour milk yellow. The plant was formerly called "Bachelor's buttons" which name, according to "Gerard," was derived from the habit country fellows had of carrying it in their pockets in order to divine their success with their sweethearts; success being augured if the sprig continued to grow. This name has also been given to other wild flowers.



Water Crowfoot.

Grant Allen speaks of the flower of the buttercup as one of the most primitive that exists. The colour of the flower is the most elementary of colours—yellow. The carpels, or little nut-like fruit, all remain distinct, and the only provision which favours one flower being fertilized by pollen from another is that the outer rings of stigmas are immature and covered by the central stamens when the outer stamens are discharging their pollen, hence bees seeking honey from the nectaries at the base of the petals, would fertilize another plant if they happened to alight at the centre, where the stigmas are first mature. Muller tells us that this plant is visited by no less than sixty species of insects.

In wet weather the flowers droop upon their stalks, and thus the rain falls off them, without washing away and wasting the pollen.

Plants belonging to the crowfoot family contain more or less of an acrid poison, in some cases they are so acrid as to serve vagrants for producing artificial sores, in order to impose upon the public sympathy. But this poison serves in many cases to protect the plants from browsing animals. The three crowfoots, named above, would have small chance of flourishing in our meadows if animals did not avoid them on account of their acrid juice. Fortunately the acrid principle volatilizes, hence hay made from buttercup meadows does not suffer in value.

The Creeping Buttercup

alluded to above is most likely the tufted crow-toe which Milton wreaths in his garland for "Young Lycidas that hath not left his peer;"

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it resembles in most respects the meadow buttercup. Remains of this plant have been found in preglacial, interglacial, neolithic, and Roman deposits; it has evidently been a common wild plant of Britain from very early times. The bulbous buttercup also so closely resembles the meadow buttercup that it is not necessary to deal with it separately.

Another crowfoot is familiar to us as one of the first flowers which peep out from the hedgerow in early spring, it is known as the

Lesser Celandine,

though, like all the more popular wild plants, it has been favoured with many English names, such as pilewort, figwort, foalfoot, and others. Its name, Celandine, is derived from its flowering when the swallows arrive, and pilewort is derived from the small knobs on the roots of the plant, which, in accordance with the doctrine of signatures, gave it remedial virtues. Figwort alludes to the peculiar fig shape of the roots.

This flower was a great favourite of Shakespeare, who alludes to it

Lesser Celadine.

Monkshood.

more than once in his poems. The following lines show what a keen observer of nature he was:—

"There is a flower, the lesser celandine,
"That shrinks, like many more, from cold and rain,
"And the first moment that the sun may shine,
"Bright as the sun herself, 'tis out again.
. . . . . .
"But lately one rough day, this flower I passed
"And recognised it, though in an altered form,
"Now standing forth and offering to the blast,
"And buffeted at will by rain and storm,
"I stopped and said with inly muttered voice,
"It does not love the shower, nor seek the cold
"This is neither its courage, nor its choice
"But its necessity, in being old."

The earliest blossoms of this plant, which open, have few petals, but later they have as many as nine petals, opening like golden stars. Some of the flowers have very few, or are quite without, stamens, the flowers, therefore, show a decided tendency towards a dioecious condition (stamens and pistil in different plants). The anthers contain very little pollen, and consequently very few seeds ripen. But this comparative infertility is compensated for, the plant being reproduced by little tubers which form in the axils of the leaves, and which become detached when the plant withers. These are sometimes produced in such numbers that they are washed out and collected in heaps, which circumstance has given rise to the myth of the potato rain.

The outsides of the petals have a greenish hue, hence when closed the flowers are very inconspicuous.

There is another crowfoot which we must not pass over, the

Goldilocks. (*R. auricomus, Lin.*)

which may be found more particularly near the edges of woods and copses. This crowfoot may be recognized by its petals varying both in size and number; sometimes being quite absent, when the bright-coloured sepals serve their purpose. This plant, therefore, explains to us how it came about that several members of this family are quite without petals, the sepals or outer whorl of flower leaves becoming brightly coloured or white, and serving both as petals and sepals.

The honeyglands on the petals are also interesting. The inner side of the triangular base of the petals has usually a thickened border on either side; this border fuses below and forms a little pit, which secrets honey, but on stunted petals we find a smaller lamina, which is fused with the larger for two or three mm., and between the two lamina two long canals are deeply sunk. These stunted petals have a striking resemblance to the petals of the winter aconite, a plant also belonging to this family. These have become reduced into small tubes secreting honey. We have, therefore, in the goldilocks not only a tendency for the petals to be replaced by bright-coloured or white sepals like those of kingcups and of the wood anemone, but also it explains how the long tubular spurs or petals of the larkspur and columbine may have been gradually evolved from ordinary petals like the normal petals of goldilocks, in which plant tubes may be found in different early stages of development (Fig. 1.).

The Hairy Buttercup

is interesting on account of the small tubercules on its little nut-like fruit, in the

Small-flowered Buttercup

these tubercules have become larger, more numerous, and surmounted by small spiny hooks, and in the

Corn Buttercup

the nuts, which are much larger than those of most buttercups, and few in number, are very prickly indeed, their prickles serving to attach them to the coats of animals, thus securing wide distribution. These three species, therefore, form a series showing how this comparatively large prickly fruit of the corn buttercup may have been evolved from the small nuts of the ordinary buttercups.

I must pass with regret the great spearwort, the lesser spearwort, and the celery-leaved crowfoot, but the

Water Crowfoots. (*R. aquitilis, Lin.*)

afford us a series of plants too interesting to overlook. They are divided by critical botanists into many species and subspecies, but these, for our purpose, may be treated as one plant, although the study of the variations of this plant would prove both attractive and profitable.

All lovers of nature are familiar with this plant, which covers our ponds in early summer with its rich green leaves and its star-like white flowers. Remains of it have been found in early glacial, late glacial, and neolithic deposits, yet in spite of their having existed so long, the fact that they root in the ground, that their flowers and fruit are aërial, and that they can adapt themselves as land plants when the ponds are dry, tell us that they are evolved from plants which grow on dry ground, and would become land plants again if circumstances necessitated it.

These plants have two forms of leaves; more or less rounded, floating leaves, which have waxy deposits in their upper cells, serving to repel any water which would otherwise block their breathing pores and prevent the air circulating in their tissues. The lower surfaces of these leaves being in contact with water are without breathing pores, which would be useless to them in that situation.

The plant has a second series of leaves, divided into hair-like segments, and which Lord Avebury suggests are so divided for the

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same reason that the gills of fish are divided into plates, so thin that they cannot support their own weight in air, but float in water, the fine division serving to secure the greatest possible amount of surface without the effort required to form a skeleton. When the plant grows in flowing water, the roots, stems, and leaves become excessively elongated, thus adapting themselves to the changed conditions, these elongated parts flowing with the stream instead of offering resistance.

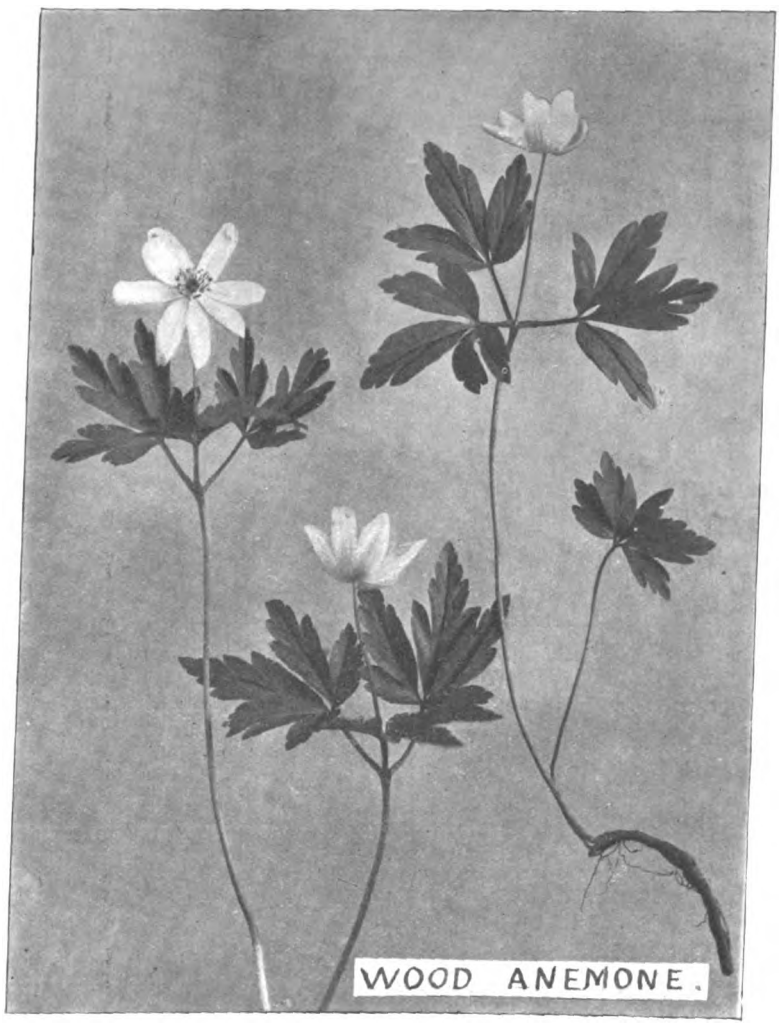
The petals are white, but often yellow at the base. According to Grant Allen, this indicates their evolution from the yellow colour of the typical members of the Crowfoot family. This yellow colour at the base may also serve to guide insects to the nectaries.

The anthers, few in number, dehisce one at a time, covering themselves with pollen, which is carried by a large number of insect visitors to other plants, thus effecting cross fertilization.

When the water in the ponds is high the flowers remain under the surface, and the buds do not open, but the pollen fertilizes the flower in bud, thus securing a supply of seed. In the

Ivy-leaved Crowfoot

we have a variety, intermediate between the land and water crowfoots,



which creeps along the mud under very shallow water, but has no submerged leaves; these would be useless to it.

In the

Marsh Marigold or King-Cup. (*Caltha palustris, Lin.*)

we have a near relative of the Crowfoots, which has been christened by no less than sixty names by English flower lovers. Its name, marsh marigold, is derived from the Anglo-Saxon Mersc-mear-gealla, that is marsh-horse-gowl, corrupted into marsh marigold.

"The wild Marsh Marigolds shine like fire in swamps and hollows gray."
Tennyson.

As already stated, the petals of this plant have quite disappeared, the sepals becoming of a rich golden colour, and serving their purpose for attracting insects.

Honey is secreted by shallow depressions in the sides of the nuts so abundantly that it often gathers into a large drop filling the space between, and although the anthers and stigmas ripen together, yet the anthers open outwards, and the outer ones dehisce first, hence an insect alighting upon the centre of a flower would bring pollen from another plant.

Remains of this plant have been found in preglacial, late glacial, neolithic and Roman deposits in Great Britain, and as its name is of Saxon origin, the plant is clearly an early inhabitant of our island.

Another member of the Crowfoot family,

Travellers' Joy. (*Clematis vitalba, Lin.*)

has received some thirty English names, amongst them lady's bower, from its aptness for making arbours, bind-with, from its use in binding faggots, old man's beard, from the appearance of its fruit, lovibond, from its habit of embracing objects it grows near, and smoke-wood, its porous stems having been used by boys for smoking.

The plant luxuriates more particularly in chalky soil, and its most noteworthy feature is the long feathery processes formed upon each nut as the fruit ripens, these serve a useful purpose by securing the distribution of the seed.

Darwin studied this plant in his researches upon plant movements. He tells us that he observed that the petioles were excited to movement by such small pressure that they embraced withered stems of grass, and even the fine flowering stems of the lesser quake grass, not thicker than the hair from a man's beard, and the stalk of a leaf, so fine that its leaflets had not yet expanded, had partially seized a twig. The stalks of almost all the old twigs are much convulated, even if not grasping an object, owing to some object to which they were attached having been removed. The few which had failed in their purpose were not so stiff as those which had grasped some object. The foliage of this plant, like most in the family, containing an acrid juice, is said to have been used by malingerers to produce skin sores.

The

Wood Anemone. (*Anemone Nemorosa, Lin.*)

is one of the most beautiful of British wild plants. There is a legend told us by Bion that it sprang from the tears of Venus.

"Wide as her lover's torrent blood appears
"So copious flowed the fountain of her tears;
"The Rose starts blushing from the sanguine dyes,
"And from her tears Anemones arise."
Polwhele's translation of Bion Idyll, 1786.

Pliny tells us that it was so named because it never opens excepting when the wind blows. But it is not quite certain that our plant is that of the ancients.

The petals have quite disappeared from the flowers of this plant. The sepals or outer whorl of the floral leaves having become white and serving their purpose. These are apt to be yellow at their bases, and tinged with lilac or purple at their apex. It is noteworthy that whilst the primitive colour yellow often appears at the base of white petals or sepals, the more advanced colours are apt to tinge their apices.

In rainy weather, and at night, the flowers not only droop, but partially close, thus effectively protecting the stamens.

Occasionally one finds flowers in which the white sepals have reverted to a foliacious character, assuming the colour and texture of ordinary leaves. I have found specimens in which one half was white and petaloid, and the other half green and foliaceous, being shaped like the bracts on the stem; the two halves were sharply divided by the midrib.

One of the most remarkable members of this family is the

Monkshood. (*Aconitum napellus, Lin.*)

which contains, perhaps, the most virulent poison known. Its most active poisonous principle, aconitine, can be separated as a crystalline alkaloid. One-tenth of a grain of this alkaloid, a quantity only just visible to the naked eye, has proved fatal to human beings. One two-hundredth part of a grain, visible only under the microscope, in a diluted solution, causes somnolence in an hour. One-thousandth part of a grain, which would only become visible under a strong microscope, causes tingling and numbness to the tongue and fauces. This tingling increases in intensity during three hours, afterwards gradually fading.

Its poisonous properties were known to the ancients. Ben Jonson says:—

"I have heard that aconite,
"Being timely taken hath a healing might
"Against the Scorpion's stroke."

And Shakespeare says:—

"The united vessels of their blood
"Mingle with venom of suggestion
"As force, perforce, the age will pour it in.
"Shall never leak, though it do work as strong
"As Aconitum or rash gun powder."
2 King Henry IV., 4, 44.

The flower of this plant has become very highly specialized, both in its form and in its colour, one would, indeed, never suspect it of being a member of the Crowfoot family.

The two posterior sepals are combined to form a helmet-shaped structure or hood, which encloses and shelters the anthers, and the nectaries. This hood also serves to press the anthers into contact with the bees which visit the flowers. The two side sepals serve to give foothold to the legs of bumble bees. Two of the petals help to enclose the anthers and pistil, whilst two are transformed into stalked nectaries, only conveniently accessible to bumble bees, and all the floral envelopes are coloured a deep purple, an advanced colour, usually associated with highly specialized flowers.

I should like also to write upon the meadow rues, the pasque flower, the mouse-tail, the hellebores, the winter aconite, the larkspur, and the columbine; all of them of great interest to the naturalist, but so rich in interest is our British flora, that it is only possible to write upon the more interesting features of our most interesting wild plants within the limits of these articles.

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Constituents of Radium.

Radium being considered as an element it is seemingly paradoxical to speak of its constituents. But the examination of radium by the spectroscope is, in fact, the examination of radium bromide or radium chloride, and when these minerals are so examined, observers have found an indication of the presence of helium. Professors Rutherford and Soddy have already pointed out the almost invariable presence of helium in minerals containing uranium; and it has seemed therefore not improbable that the helium which might exist in radium bromide was being liberated in connection with the vibration of the molecules of radium—in other words with, or because of, the movements of the electrons of the molecules of radium. The molecular vibration would be similar to that which would be set up in gaseous helium itself by an electric discharge.

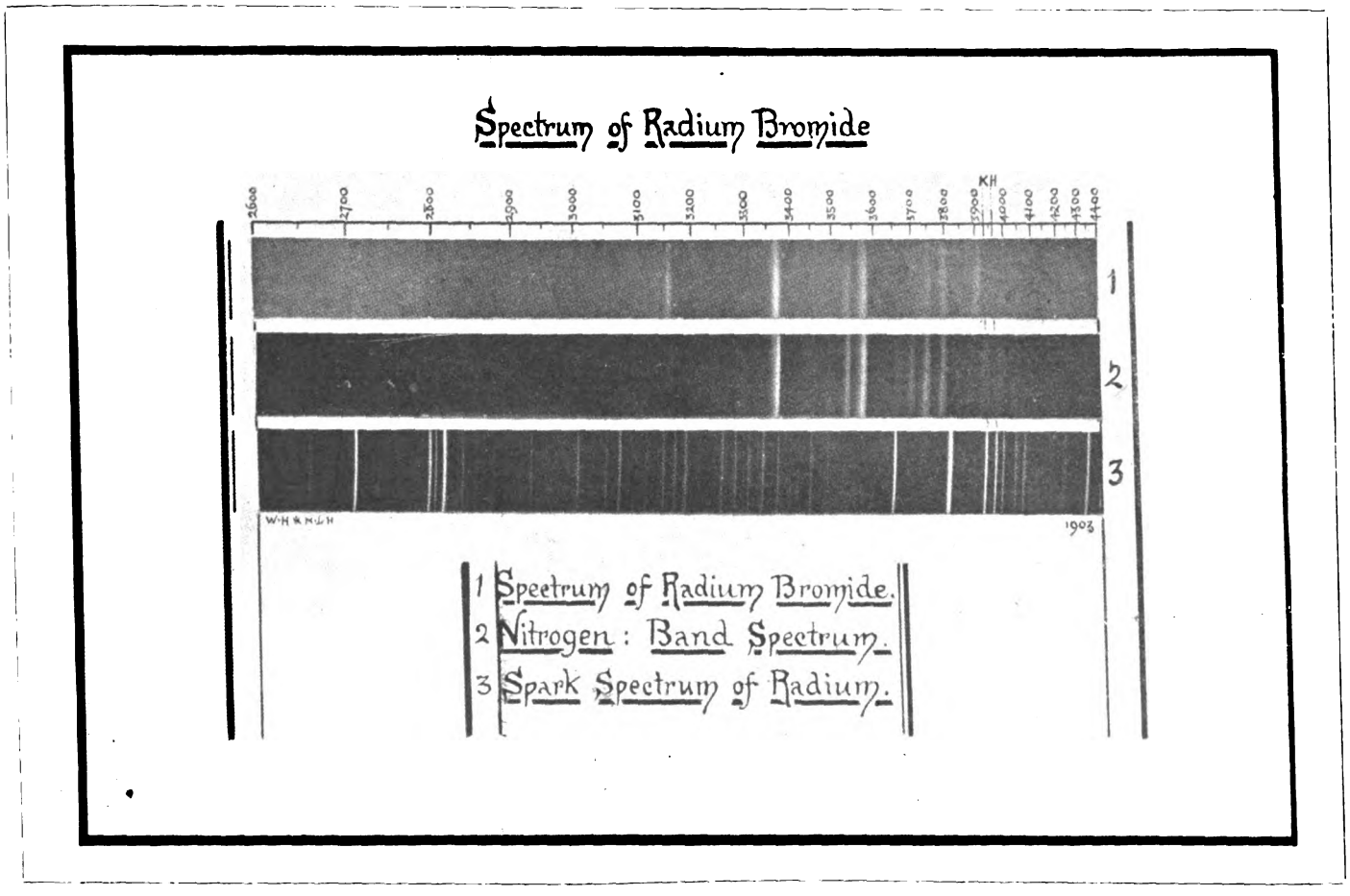
The latest examination of the spectrum of radium has been made by Sir William Huggins and Lady Huggins; and the following is an abstract of the paper they presented to the Royal Society:—

The discovery of an element possessing such remarkable and novel properties as radium, which in its separate and distinct form as a new chemical element we owe to the researches of Professor and Mdme. Curie, has already thrown many beams of suggestive light into the very obscure regions of the constitution of matter. In radium we have a body which appears to be spontaneously and without ceasing giving off energy in several forms. According to Professor Rutherford, following upon the work of Becquerel, M. and Mdme. Curie, and others, the emanations going off from radium are at least of three kinds. First, an emanation of heavy corpuscles, larger in mass than the hydrogen atom, moving with a high velocity, and carrying a positive charge;* secondly of negatively charged electrons which form a powerful and penetrating cathode emanation;† and further, of a radio-activity which diffuses from the radium as if gaseous in its nature. In addition, M. and Mdme. Curie have found that radium spontaneously maintains a temperature about 1°·50 C. above the surrounding temperature, and therefore emits heat radiations of wave-lengths falling within the infra-red part of the spectrum.

Now, in addition to these forms of radiant energy, the glowing of radium in the dark shows that it emits a luminous radiation spontaneously at ordinary temperatures. It appeared to us probable that in this glow we had not to do with either phosphorescence or fluorescence as usually understood, but with an independent and continuous radiation set up by those more active molecules which are supposed, in consequence of a condition of internal instability, to be the source of all the phenomena of radio-activity, and which can scarcely fail themselves to be violently agitated, in connection with disruptive molecular changes—especially the flinging off of the heavy corpuscles—during which part of the energy stored up within the molecule is liberated in the kinetic form.

Taking this view of the luminous radiations visible to the eye, it seemed highly probable that the molecular motions by which they were set up, whether we suppose all the radium molecules alike to be concerned, or those only which are in active change, would be so far analogous to the vibrations produced artificially, when radium vapour is rendered luminous in a flame, or by the blow of an electric discharge, as, in like manner, to set up radiations of certain definite wave-lengths or, in other words, to furnish a spectrum of bright lines.

A preliminary prismatic examination of the glow from pure radium bromide was attempted by eye. In consequence of the feebleness of the light under dispersion a slit spectroscope could not be used. A thin fragment of some length of radium was selected, which in the dark shone as a narrow line of light; when this was viewed through a direct-vision prism, it was seen to be dispersed into a spectrum which extended down the blue line to about D, where it became too faint to be traced farther in the direction of the red. Within this faint spectrum certain spots were distinctly brighter, due, in all probability, to the presence of bright lines at those positions in the spectrum.



The success of this preliminary observation encouraged us to hope that it might be possible, by availing ourselves of the accumulative power of continuous photographic exposure, to obtain a record of the blue, violet, and ultra-violet regions of the spectrum, if the glow radiations extended so far.

With an exposure of 24 hours, faint traces of two lines were seen on the plate. After several trials the negative reproduced on the accompanying plate was obtained with an exposure of 72 hours. The reproduction is enlarged two and a-half times. The spectrum consists of eight bright lines, and at least eight faint lines, together with a faint trace of continuous spectrum in the blue region, which does not come out in the reproduction.

It was seen at once that the two very strong characteristic rays of the spark spectrum of radium, in this part of the spectrum, were not present on the plate. It was clear that the spectrum was not that of the radium molecule when excited by the electric discharge. It was indeed not improbable that if the radiation came alone from the most active molecules, which were suffering loss by material emanations, then, if we may accept the analogy from sound, like a filed tuning fork they would no longer give radiations of the same wave-lengths as before.

As soon as measures were taken of the lines it was found that several of them agreed in position within the uncertainty of the measures with lines in the spectrum of helium, but not with the most characteristic helium lines in this part of the spectrum. Now Rutherford and Soddy had pointed out the almost invariable presence of helium in minerals containing uranium. It seemed, therefore,

* These are the α particles. Professor Rutherford has since written to express his belief that these α particles are in reality helium.

† As an illustration of the penetrative power of the radio-active effects of pure radium bromide, the following experience may be recorded here: About 1 centigramme of radium bromide (Buchler and Co., Brunswick) had been placed in an upper drawer of my writing table, while in a lower cupboard of the same table was a store of photographic plates. After a week or two, all the plates, in boxes lying upon each other three or four deep, were found to be as completely fogged as if they had been exposed to light.

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not impossible that we might have to do with the helium contained within the radium bromide, and that this gas was being liberated in connection with the active molecules in a state of molecular vibration, analogous to that set up in gaseous helium by an electric discharge.

Further examination of the new spectrum, stimulated by the unsatisfactory fact that the strongest lines of helium were not represented in the spectrum from radium bromide, showed, however, quite unexpectedly that, if the new spectrum were slightly shifted relatively to the scale, then the seven strongest lines would agree not only in position, but also in relative intensity and character, with bands of the spectrum of nitrogen.

Sir William Huggins shows reasons for accepting this correction and continues: Indications of other lines, besides those which can be seen in the reproduction, can be faintly glimpsed on the negative. There seems little doubt that with a longer photographic exposure a more complete spectrum will be obtained. We have now secured some radium bromide prepared by the *Société Centrale de Produits Chimiques*, and it is our intention to take photographs of this salt as well as photographs of the German salt with longer exposures. It may then be that indications of helium, and possibly of radium itself, may be forthcoming. Nearly the whole of the ultra-violet radiations appear to come from nitrogen, and we think it best to refrain from any discussion at this moment. Have we to do with occluded or with atmospheric nitrogen? The remarkable fact should be pointed out that in radium we have a body which at the ordinary temperature sets up radiations which are similar to those which have hitherto only been obtained in connection with the electric discharge.

Description of Plate.—At the top is placed a scale of approximate wave-lengths. Immediately below is a reproduction, enlarged two a-half times, of the spectrum obtained from the radium bromide with an exposure of 72 hours. As has been already explained this has been shifted to bring the lines into position with those of nitrogen photographed from a vacuum tube. The identity of the two spectra seems complete. The third band is faint in the nitrogen spectrum on account of the absorption of the glass of the tube.

Below, is a spark spectrum of radium bromide from the *Société de Produits Chimiques*. The H and K lines of calcium are present, as well as faintly some of the stronger lines of barium. The characteristic lines of radium at 3814·59 and 3649·7 come out strongly, as well as the strong line recorded by Demarcay at 4340·6. A strong line about 2710 was placed by Berndt at 2708·6. The strong line a little beyond, about 2814, is due to radium. We do not recognise several lines recorded by Exner and Haschek in this part of the spectrum.

On a Novel Teleoptical Apparatus.

NUMEROUS endeavours have been made with a view to transmitting by telegraphy handwriting, drawings, etc., more or less lucky solutions of this problem having been suggested of late years. As the transmission of pictures with their own colours presents special difficulties, Mr. S. T. Schneider, in a paper published in the *Electrot Anz*, suggests transmitting only the contrasts between light and shade. Wireless telephony has shown selenium cells to afford a means of detecting and of transmitting to a telephone, by converting them into oscillations of current, extremely low variations of luminous intensity, even in the case of these variations occurring at a very high rate. When shifting simultaneously on both sides of a photographic plate a beam of light and a selenium cell, the variable intensity of each point of the plate will give rise to continuous oscillations of the current in the circuit of the cell. If the ray and the cell are moved along in directions parallel to A-B (Fig. 1) the whole of the picture is reviewed, each point of the latter corresponding with a certain resistance of the selenium cell. Professor Simon has shown that by means of oscillations of current, fluctuations in the luminous intensity of an electric arc may be produced, these oscillations (due to variations in the resistance of the selenium cell, which, in turn, are to be ascribed to the variations in the intensity of the photograph) being utilized by the author to reproduce the picture. In the opinion of Herr Schneider a beam of light emanating from an arc lamp placed at a receiving station, and influenced by the circuit of the selenium cell, will undergo a modification synchronous with that of the transmitting ray. The luminous trace drawn by this beam on a ground-glass plate shows accurately all the details of the original.

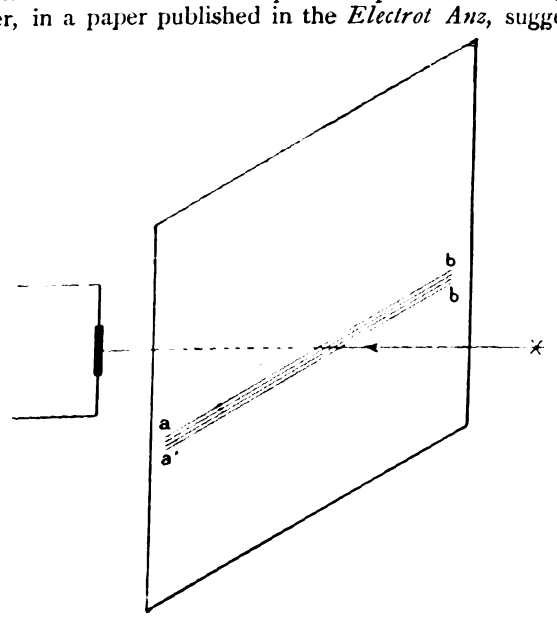

Fig. 1.

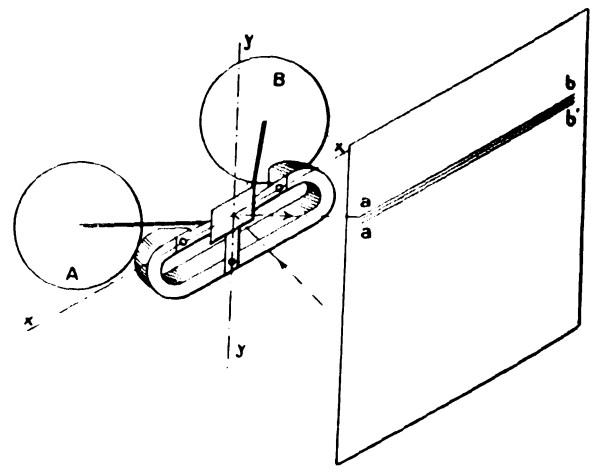

Fig. 2.

When decomposing the latter into lineal strips and recomposing them in the receiving apparatus, the whole of the picture may be reproduced. As a matter of fact this decomposition and reproduction should occur with an extreme velocity in order that the eye may receive an impression of the picture as a whole. This speed, as well as the indispensable synchronism, is obtained by a device analogous to that designed in connection with Pollak-Virag and Gruhn's telegraphic apparatus. By means of current modifications a telephonic membrane receives vibrations of a very high frequency. A small mirror with magnetic suspension will execute under the influence of the membrane A (Fig. 2) vibrations about the axis of the y, whereas the membrane B causes the mirror to rotate round the axis of the x by a certain angle. This angle should just be sufficient to place the luminous trace after one vibration is finished accurately below the former. In this way a surface and a perfect image are produced.

The sending apparatus is arranged in the following way (Fig. 3): The arc lamp B projects on the small mirror G, a beam that is reflected by the latter and through the condenser system C, and the plate P, strikes the selenium cell after traversing the convergent length L. At the receiving station the selenium cell acts on the arc lamp B1

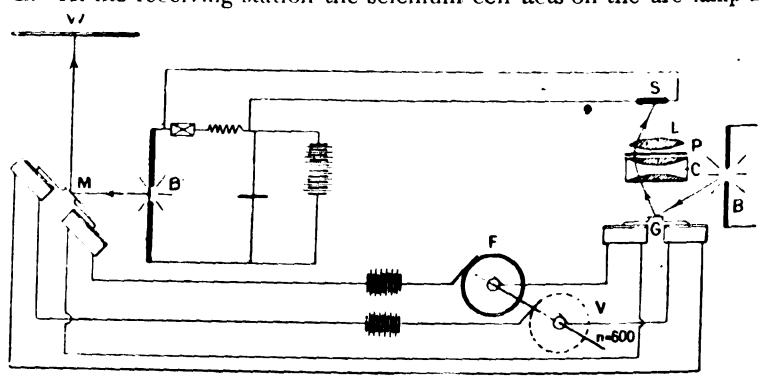

Fig. 3.

arranged according to E. Ruhmer's scheme, the light of which strikes the small mirror M of the receiving apparatus, by which it is thrown on a ground-glass plate W. In order to produce the horizontal oscillations of the mirror as well as their vertical rotation round the axis of the x, Mr. Schneider inserts in the circuit of one of the membranes an interrupter F, whereas that of the author contains a resistance modifier V. These two attachments mounted on a common axle by rotation are made to rotate by a small electro-magnet. The interrupter produces a number of current shocks equivalent to the number of horizontal strips into which the picture is decomposed, whereas the resistance modifier produces as many graduations in the same time. After each rotation the resistance being equal to zero, the luminous ray will instantaneously return to its initial position. The interrupter may easily be made to produce the convenient number of shocks per second, this number being equal to the product of the number of strips by the number of reproductions of the whole of the picture per second. The other apparatus should, of course, produce in the same time the same number of modifications of the resistance from zero to the maximum value as reproductions are made per second. This apparatus enables photographs to be transmitted by telegraphy over any desired distance, and either to be made visible to the eye in a temporary way or to be fixed by photography.

A. G.

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Continental Physical Notes.

BY DR. ALFRED GRADENWITZ.

On Electric Air Currents.

IN the Journal of the Russian Physico-Chemical Society, S. Lemström discusses the interesting properties of the currents termed electrical air currents, to which he ascribes an important part with natural phenomena. According to the definition of the author, such currents are produced whenever an electrical circuit is broken by a layer of air, provided the difference of tension at the two terminals exceeds a certain limit; not only in Polar countries but anywhere in the air, the presence of such currents may be shown. The author thinks he is warranted in assuming that the *Aurora Borealis* is due to their action; in fact, he is able to produce, by means of a specially designed apparatus, a luminous phenomenon showing the wave length characteristic of the *Aurora Borealis* ($\lambda = 5569$). Moreover, he finds electric air currents in Polar countries, and especially during an *Aurora Borealis*, do undergo considerable fluctuations. The relations existing between the phenomena in issue and the atmospheric conditions are equally interesting. As, for instance, part of the water contained in the air assumes a form of small suspended liquid spheres, the electrical resistance of the air must be altered to a considerable extent by increasing moisture. Very notable variations in both the strength and direction of the current are, therefore, stated before, during, and after rain falls. The effect exerted by such currents on magnetic needles is, as well, noteworthy; but the influence on vegetation as observed by the author, is particularly interesting. Lemström thinks the rapid development of vegetation during the brief Polar summer to be connected with this phenomenon—*e.g.*, he finds atmospheric currents to give rise to certain chemical combinations—the formation, for instance, of nitrogen compounds. These compounds may, under certain conditions, be driven by such currents into the capillary vessels of the plants. The curves, representing the behaviour of electro motive forces of such currents, in spite of certain similarities, show noticeable diversities as to all particulars from the curves of the static potential differences simultaneously observed by means of the electrometer, thus illustrating the diversity of these two classes of phenomena. The author finally suggests undertaking methodical observations of the above currents in all the meteorological observatories.

Pure Water a Poison.

The fact that chemically pure water—*i.e.*, water as obtained by distillation and sometimes as melting water from pure ice—rain water, as well as water from some few fountains will exert on the human body an effect pernicious and even poisonous has been shown by Koepp's and Van't Hoff's recent investigations.

This startling fact may be accounted for on the laws of physical osmose. If, indeed, two solutions of different concentrations be separated by a membrane permeable to the solvent, but impervious to dissolved body, there will be a pressure on the partition wall proportional to concentration. If, however, outside of a cell of the human body there be chemically pure water, the interior being filled with a more or less concentrated solution, the osmotic pressure may prove sufficient to destroy this cell.

This agrees well with the fact that such water has a disgusting taste, producing vomiting.

The water of certain fountains, but especially melting water from ice and freshly fallen snow, should, therefore, be strictly cautioned against.

On the Theory of the Critical State.

Recent investigations by De Heen, Galitzine, Battelli, and others have given results which, seemingly, do not agree with Andrew's theory of the critical state. Variations as high as 100 per cent. have, *e.g.*, been shown to exist in the same tube above the critical temperature and at a constant pressure. As, however, the conditions of experiment under which the densities were determined are somewhat doubtful, it was interesting to check these results by a new method free from such uncertainties. This method consisted in determining the density both below and above the critical temperature by means of small glass balloons floating inside of the tube in question. Similar experiments, as recorded in a paper read at a recent meeting of the German Physical Society, were carried out by I. Traube and G. Teichner. A complete set of small glass balloons of different densities being prepared, the densities of the balloons were determined by ascertaining the temperature at which the balloon would become suspended in heated ether. Experiments showed that the balloons as far as 10° above the critical temperature would be kept for hours in suspension at different heights corresponding to their density and that of the surrounding medium, thus giving evidence of differences in density as high as 50 per cent. and more, though a perfect equilibrium both of temperature and pressure was obtained.

These experiments go to show that Andrew's theory is false, as different densities may co-exist at the same pressure. Two different matters must accordingly co-exist at the critical temperature, one being liquid and one being gaseous, the critical temperature being the point at which both matters are miscible at any ratio, whereas a partial miscibility has been observed at temperatures far below the critical point.

New Facts about Blondlot's N-Rays.

Some interesting phenomena in connection with Blondlot's N-rays are recorded in a recent note read before the French Academy of Sciences. The action of N-rays on a small flame suggested the possibility that a similar action should be exerted on a solid incandescent body. In order to test this, a platinum wire about 1 mm. in diameter and 15 mm. in length, was brought to a dark red heat by means of an electric current. On this wire a beam of N-rays, as emitted by an Auer-burner through wood and aluminium screens and concentrated by a quartz lens, was directed, when the wire was observed through a ground glass plate attached to the same holder. By shifting the wire a series of focis would be detected as in the case of other processes capable of showing the presence of N-rays. The wire being placed at one of these focis, a lead screen, or else the hand was interposed in the way of the rays. The luminous trace then formed on the ground glass was found to become less brilliant. As these obstacles were taken away, the spot would resume its former brilliancy, these actions seemingly not being instantaneous.

The above experiments were generalized by using, instead of a hot wire, a platinum plate brought partly to a dark red by means of a small gas flame placed below. A horizontal beam of N-rays concentrated by a lense was directed on the inferior face of the plate so as to produce a focus at the heated spot, when an incandescent point would be observed on the superior face without interposition of a ground glass plate. The same results were obtained, if, instead of directing the N-rays on the inferior face of the plate, *i.e.*, on the side of the heating flame, the rays struck the superior face.

The different effects produced by N-rays, *i.e.*, their action on the spark, on the flame, on phosphorescence, and incandescence, would lead one to think that these rays should act by heating the bodies undergoing their actions. In order to elucidate this question, the author installed a thermo-electric cell connected to a galvanometer. Now, the actions of the rays on this apparatus was absolutely nil, even in the case of most favourable conditions.

In the above experiments on a platinum plate the increase in brilliance was observed on both of the plates. Now, as no rise of temperature was noted, this fact seems paradoxical; as, in fact, N-rays do not traverse platinum, no action on the opposed face of the plate should be expected. In order to allow for this phenomenon the author presumed that N-rays, though not traversing cold platinum, are readily transmitted through the incandescent metal. This hypothesis was confirmed by experiment. A lead screen being interposed between the platinum plate and the light source, no effect could be observed on the small flame, this showing evidence of the opacity of the platinum. As soon, however, as the platinum plate was brought to a red heat, the interposition of the lead screen was found to diminish notably the intensity of the small flame. Hence, the N-rays emanating from an Auer-burner are transmitted through incandescent platinum.

Electrically-Driven Looms.

An interesting co-operative enterprise has recently been started in the Southern Black Forest. The looms of upwards of 500 domestic weavers are to be driven by electricity. The total cost of establishment for the power plant is estimated at about £17,000, this sum to be supplied by the Wald-Elektra Sackingen Waldshut Power Co., apart from a subvention granted by the Government. The great advantage of this enterprise will be that silk ribbon weaving will be enabled to be preserved as a domestic industry, securing a yearly income of about £15,000 to the poor inhabitants of the Forest. Moreover, the new system of operation will put the physical strength and health of the weavers to a much less strain, so that persons of even moderate strength will be in a position to devote themselves to domestic weaving, thus allowing of a division of work between the members of the same family being made, especially during the season of rush in the silk trade. Moreover, the weavers will be enabled to work stouter goods, securing them higher profits, apart from the sanitary advantages attendant on electrical operation and lighting.

Trees in Towns.

THE roots of trees which are planted along the pavements of the streets in towns very frequently experience great difficulty in "breathing." They are not sufficiently exposed. It is true a certain free space is left around the tree, but this is not enough to assume aëration of the soil. Endeavours were recently made to remedy this at Messina. A number of Phœnix palms are planted on the Hotel de Ville Square in holes filled with 2,824 cubic feet of vegetable mould. The soil is exposed to the air on an area of $3\frac{1}{2}$ sq. yards around the tree, the remaining portion of the ground being paved with a mosaic work of small stones particularly impenetrable to atmospheric oxygen. To allow the air to reach the roots a ramification of drain pipes was adopted. At a distance of 1.6 yard from each tree an ordinary stone pipe was placed in the soil surrounded with broken stones, the larger, the nearer they are to the pipe, with the object of preventing the latter from being obstructed. Smaller pipes run from the main along four sides around the tree, and the large pipe terminates in a ventilating shaft, which opens out on the edge of the footpath. Very simple arrangements prevent rain from entering these air pipes, which have their outlet well above the bottom of the shaft; as this bottom communicates with the sewers, watter cannot accumulate. The system is, perhaps, a little costly, but these precautions may save money for replacing trees, which would perish for want of underground air.

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The British Association, 1903.

The Meeting at Southport.

THERE is reason for hoping that the meeting of the British Association at Southport this month will establish itself as having marked the beginning of a new era in the Association's educational activity. After two-and-a-half generations the British Association still represents more completely than any other institution the force of scientific opinion in England; and its great influence will be directed this year to the awakening of the nation to the pressing needs of scientific education. The first words of the exordium were spoken last year in Professor Dewar's Presidential Address and they were supplemented by Professor Perry's address to the Engineering Section. This year the President, Sir Norman Lockyer, will insist once again on the nation's duty, and on the duty of all scientific workers, in this matter; and the needs which he points out will be reviewed, and their vital nature disclosed from many points of view, by more than one of the Sectional Presidents—notably by Professor C. Vernon Boys in the section of Mathematical and Physical Science, by Professor William Watts in the Geological Section, and by Professor Sydney J. Hickson in the Zoological Section. Of the other aspects of the meeting at Southport this year we need say little by the way of preface. An exhibition of meteorological and magnetic instruments, diagrams, etc., will be held in the Science and Art Schools, and its general importance will be enhanced by the meteorological exhibits of the International Meteorological Committee, held contemporaneously in Southport. Greenwich Observatory, Sir Norman Lockyer's observatory at South Kensington, Kew Observatory, and the Meteorological Societies of England and Scotland, are all sending exhibits. Captain Creak, R.N., who is the President of the Geographical Section, will lend instruments and charts; and Dr. Roth, Mr. Joseph Baxendell, and Mr. W. H. Dines, are all contributors. Last year the British Association appointed a committee for the investigation of the upper air by means of kites; and Mr. W. H. Dines is proposing to show the working of the kites to the members of the Association. One of the methods of giving height of ascent to the kites is to draw them along over sea or lake at the stern of a small tug or steamer. At the request of the Royal Society the Lords of the Admiralty lent a small vessel for the pursuance of these experiments, and the kite-flying experiments were to have been witnessed off the Lancashire coast. Unfortunately the vessel sank in Devonport Harbour just before she should have started north, and is, therefore not available. However, the local committee is in negotiation for a steamer for the period of the meeting, and the experiments may after all be shown to members. One of the excursions this year will be of a novel and, perhaps, exciting kind. The excursion to Hoole and Rufford will take the form of a motor-car run. More than twenty cars have been placed at the disposal of the committee by their owners, and it is hoped the excursion will be a popular one.

The President, Sir Norman Lockyer.

SIR NORMAN LOCKYER is the Director of the Solar Physics Observatory, South Kensington, and his researches, dated from there since 1879, are the chief record of his own life-work and that of the Observatory. He was born at Rugby on 17th May, 1836, and was educated privately and on the Continent. He was appointed to the War Office 1857; and edited the Army Regulations of 1865. He became Secretary to the Duke of Devonshire's Royal Commission on Science in 1870; and was transferred to the Science and Art Department in 1875. He was elected a Fellow of the Royal Society in 1869; and became Rede Lecturer at Cambridge in 1871. The French Academy appointed him a correspondent in 1875 (Jansen Medal). He has been the chief of the English Government Eclipse Expeditions of 1870, 1871, 1882, 1886, 1896, 1898 and 1900; and the eclipse of 1878 was observed by him in the United States.

Publications.—The briefest list of Sir Norman Lockyer's publications includes:—"Elementary Lessons in Astronomy" (1870), "The Spectroscope and its Applications" (1873), "Princes of Astronomy" (1874), "Studies in Spectrum Analysis" (1878), "Star Gazing, Past and Present" (1878), "Chemistry of the Sun" (1887), "Movements of the Earth" (1887), "Meteoritic Hypothesis" (1890), "Dawn of Astronomy" (1894), "The Sun's Place in Nature" (1897), "Inorganic Evolution" (1900).

Besides the foregoing works, an amount of work which can only be described as immense is embedded in papers submitted to the Royal Society and other scientific bodies, and is to be found in the "Royal Society Proceedings," the "Philosophical Transactions of the Royal Society," the "Philosophical Magazine," and *Comptes Rendus*. The first paper on "Spectroscopic Observations of the Sun" is in the "Proceedings of the Royal Society," October 1866; the second in the "Philosophical Transactions," November, 1868. Since that time Sir Norman Lockyer has contributed to the learned societies and publications we have mentioned more than 130 papers on the investigations with which his name is inseparably connected. "Stellar Spectroscopy"; "The Chemistry of the Sun"; "The Spectra of the Gases"; "The Spectra of Meteorites and Nebulæ"; "The Causes Which Produce the Phenomena of New Stars"; "Spectrum Observations of New and Rare Gases;" "The Investigation of the Sun's Atmosphere and Sun Spots"; "The Possible Connection between Solar and Terrestrial Phenomena"; and "The Relation of Sun Spots to Earth Magnetism and Earth Weather"—these are the subjects with which his commanding ability and indomitable energy and industry have concerned themselves for a period extending over more than a generation.

Subject of Address:—

Sir Norman Lockyer's Presidential Address will be a plea for the organization of Science and he will suggest that the British Association should take upon itself the functions of a Guild or League. Sir Norman Lockyer will then state that in his opinion the most important things to fight for now are:—

I. The Endowment of Universities—Universities being as important to the nation's welfare and future as the battleships on which we have spent a hundred-and-twenty millions of pounds.

II. The Endowment of Research.

III. The appointment of a Scientific Council to look after our commerce and education as the Council of Defence looks after our armaments.

Sectional Addresses and Work.

Section A.—Mathematical v. Physical Science.

Prof. Charles Vernon Boys, F.R.S., President of Section A, was Demonstrator (1881), and Assistant Professor of Physics at the Normal School of Science and Royal School of Mines (now Royal College of Science), 1889. This position he resigned at the beginning of 1897 on being appointed one of the Metropolitan Gas Referees by the Board of Trade. He was elected a Fellow of the Royal Society in 1881, and was a member of Council of the Society from 1900-1902. He was awarded a Royal medal by the Royal Society in 1896. He was a member of the Departmental Committee appointed in 1895 to enquire into the causes of explosion and the precautions required to ensure the safety of cylinders of compressed gas. In 1897 he was appointed an extra-member of the Dangerous Trades Committee appointed by the Home Office to enquire into the conditions of work of operatives in electrical generating works; and in 1901 on the Committee to enquire into the dangers of acetylene generators. He was a member of jury to the Paris Exhibitions of 1887 and 1900, and is a member of the Royal Commission for the St. Louis Exhibition 1904.

Publications.—Papers to the Royal Society, Physical Society, Royal Institution, and Society of Arts. Among others are papers, "Integrating Machines," on "Quarts Fibres," on "The Radio-merometer," on "The Photography of Bullets," on "The Newtonian, Constant of Gravitation," besides articles on "Electricity *v.* Magnetism" and "Soap Bubbles and the Forces which mould them." He is a brilliant lecturer and demonstrator, in both of which capacities he is very well known.

Subject of Address.—Professor Vernon Boys' Presidential address will dwell on the great importance of the physical sciences to the nation, not less from an intellectual than from a material point of view. He will urge that the place these sciences should occupy in the nation's education should be a larger one; and will insist that as a means of training the mind they are of a usefulness in no degree inferior to that of the subjects at present taught, and too frequently badly taught, in English public schools.

Work of the Section.—For the following particulars, as for those of the work in other sections, we desire to express our indebtedness to our contemporary, *Nature:*

The physical portion of Section A will be mainly occupied in discussing three questions of considerable interest to physicists at the present time. The Nature of the Emanations from Radio-active Substances will be introduced as one of the subjects for discussion by Prof. Rutherford, of Montreal, and it is expected that several visitors from the Continent will take part. Mr. Swinburne will introduce a discussion of the method of treatment of non-reversible processes in thermodynamics, in which Prof. Perry and others will have something to say, and Prof. Henrici will direct attention to the desirability of introducing vectorial methods into physics to a much larger extent than has been done hitherto. Sir Norman Lockyer will discuss the agreement in time between certain solar and terrestrial phenomena. Papers have been promised by Prof. Turner, Dr. W. J. S. Lockyer, the Rev. A. L. Cortie and Mr. Hinks, and there will be an exhibition of photographs from the Yerkes Observatory.

Section B.—Chemistry.

President.—Professor Walter Noel Hartley, D.Sc., F.R.S., L. & E. Professor Hartley is Professor of Chemistry, Royal College of Science for Ireland. Honorary Fellow of King's College, London, formerly Vice-President of the Institute of Chemistry of Great Britain and Ireland.

Publications.—"Air and its Relation to Life," 1876; "Water, Air, and Disinfectants," 1877; "Quantitative Analysis," 1887. Author of

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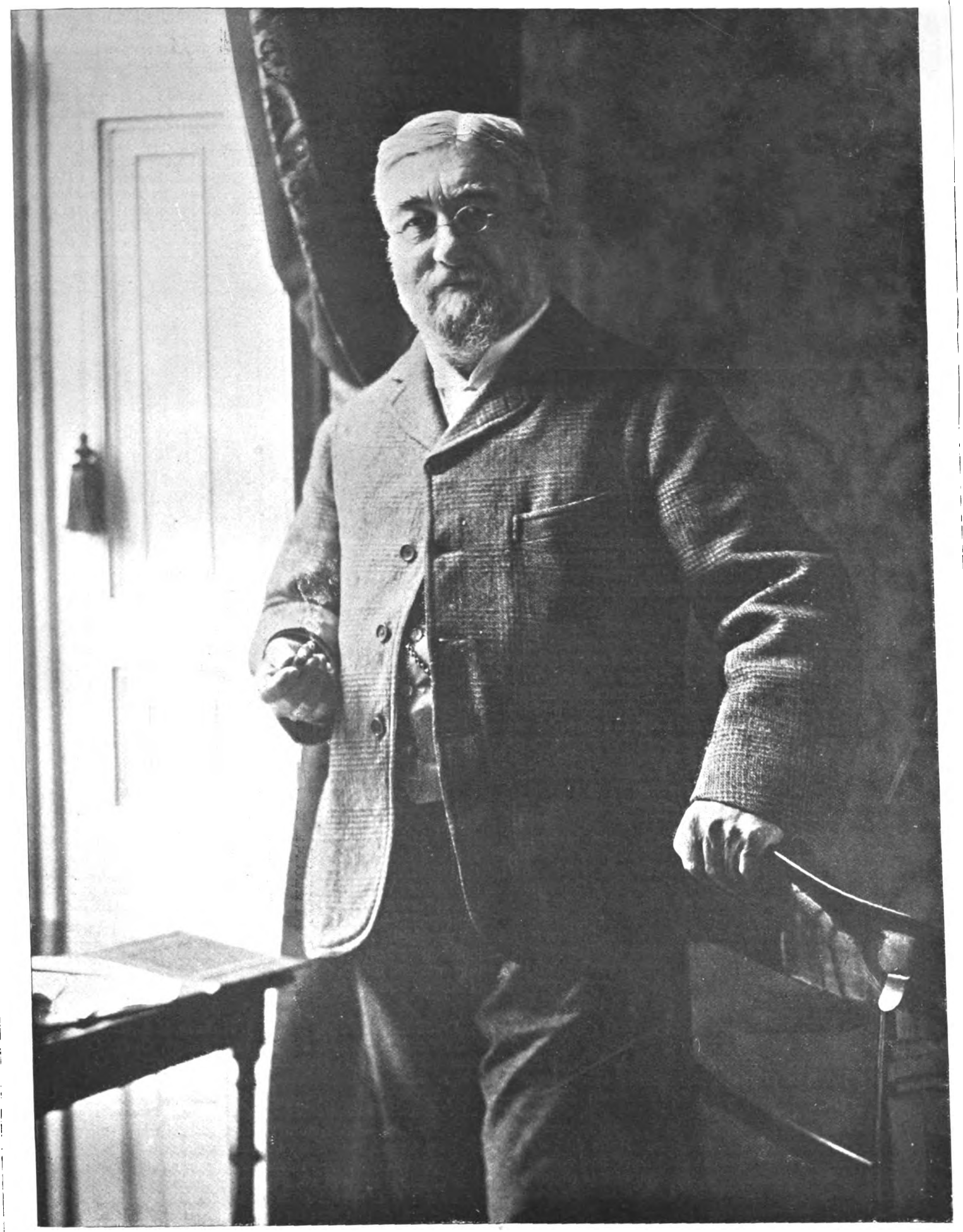

[Photo by Byrne.

SIR J. NORMAN LOCKYER, K.C.B.

President of the British Association, 1903.

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Professor C. VERNON BOYS. *[Photo by Methuish*

papers in the "Philosophical Transactions and Proceedings of the Royal Society," the "Journal of the Iron and Steel Institute," the "Transactions of the Chemical Society," the "Scientific Transactions and Proceedings of the Royal Dublin Society"; in the "Astrophysical Journal of the United States" and Reports to the British Association.

Subject of Address.—Professor Hartley's address will deal with absorption and emission spectra, and the uses of physical chemistry. He will review the last twenty-five years' work in spectroscopy applied to the constitution and composition of terrestrial substances, both organic and inorganic, and he will discuss the present position of spectroscopy chiefly in relation to chemical theories, indicating where it may be usefully and profitably extended.

Work of the Section.—The following papers will be read:—"Dynamic Isomerism," by Dr. T. M. Lowry; "Hydroaromatic Compounds," by Dr. A. W. Crossley; "The Cause of the Lustre produced during the Mercerising of Cotton," by Mr. J. Hübner and Prof. W. J. Pope, F.R.S.; "Mutirotation and the Glucoside Formula of Glucose," by Dr. E. F. Armstrong; "A Contribution to the Constitution of the Disaccharides," by Mr. T. Purdie, F.R.S., and Dr. J. C. Irvine; "Some Derivatives of Flourine," by Miss Ida Smedley; "Fluorescence as Related to the Constitution of Organic Substances," by Dr. J. T. Hewitt; "The Cholesteral Group," by Dr. R. H. Pickard; "On Essential Oils," by Dr. O. Silberad; "Freezing Point Curves of Binary Compounds," by Dr. J. C. Philip; "Action of Diastase on the Starch Granules of Raw and Malted Barley," by Mr. A. R. Ling; "Action of Malt Diastase on Potato Starch Paste," Part I., by Mr. B. F. Davis and Mr. A. R. Ling; "Action of Malt Diastase on Potato Starch Paste," Part II, by Mr. A. R. Ling; "Some Properties of Sodium Hydride," by Mr. A. Holt; "On a method of separating Cobalt and Nickel and the Volumetric Determination of Cobalt," by Mr. R. L. Taylor; "The Influence of Small Quantities of Water in bringing about Chemical Reaction between Salts," by Dr. E. P. Perman; "Sur le Spectre du Silicium" and "Sur les Procedes de Photographic Spectacles Applicables a la Pratique des Laboratoires de Chimie," by M. le Comte Arnand de Grammont. Dr. W. A. Bone will open a discussion on the general subject of combustion by a paper on the combustion of methane and ethane.

Geology.

President.—Professor William Whitelaw Watts, M.A., D.Sc., F.R.S. Professor Watts. who was a Scholar and Fellow of Sidney-Sussex College Cambridge, was lecturer to Cambridge University Exterium 1882-91; member of H.M. Geological Survey of Great Britain and Ireland, and is now Assistant Professor of Geology and Physiography at Mason's College, the University of Birmingham. He is the Secretary of the Geological Society, and has done valuable original research chiefly among the Cambrian and Silurian rocks, much of it in company with Professor C. Lapworth.

Publications.—Author of Papers on Geology of Shropshire, Montgomeryshire, and the Birmingham District (Quart, Jour. Geol. Soc., Rep. Brit. Assoc., and Proc. Geol. Assoc.); Charnwood Forest ("Geological Magazine" and "Geographical Journal"); the Isle of Man, etc. Contributor to Maps and Memoirs issued by the Geological Survey, especially N. of England, S. Wales, Leicestershire, and Isle of Man. Author of "Description of the Rocks and Fossils in the Collection of the Geological Survey of Ireland," practically a text-book of the Geology of Ireland, 1895. "Geology for Beginners" (Macmillan). Secretary and Recorder of Section C from 1886-1894. Since 1896, Secretary of the Geological Photographs Committee of the British Association, author of seven annual reports on the subject, and in charge of collection of 4,000 photographs. Editor of "British Geological Photographs," published by the Committee.

Subject of Address.—Professor Watts will deal with "Geology in Education and in Practical Life." The claims of geology to be taught as an observational science in schools and colleges, as well as the more purely experimental sciences. The necessity for the teaching of it because if its economic applications and its use in many professions. The importance of the science in the development of the mineral wealth of the country and the Empire. the source of all our prosperity and importance.

Work of the Section.—The following papers are promised:—"On the Disturbance of Junction-beds from Differential Shrinkage during Consolidation," by Mr. G. W. Lamplugh; "On the Igneous Rocks of Weston-super-Mare," by Mr. William Boulton; "On the Igneous Rocks of the Berwyn Mountain," by Mr. T. H. Cope and Mr. J. Lomas; 'On the Recent Work of the Geological Survey," by Dr. J. J. H. Teall, F.R.S.; "Lower Ordovician Rocks in the Neighbourhood of Snowdon and Llanberis," by Mr. W. G. Fernsides; (1) "On the Origin of Certain Quartz Dykes at Foxdale. Isle of Man," (2) "On some

Professor W. W. WATTS.

Glacial Lakes in Switzerland," (3) "On the Geology of the Country Around Southport," by Mr. J. Lomas; "On the Porosity of Rocks," by Mr. C. C. Moore; "Notes on Sarsen Stones, with Special Reference to the Stones at Stonehenge," by Mr. H. W. Monckton; "On the Geology of Martin Mere," by Mr. H. Brodrick; (1) "On the Origin of Eruptive Rocks," (2) Observations on the Metalliferous Deposits of the South of Scotland," by Mr. J. G. Goodchild; (1) "On the Origin of the Drift Deposits of Lancashire and Cheshire," (2) "On the Striation of Boulders on Modern Beaches," (3) "Observations upon the Evidences for the Former Existence of Glacier-Lakes in N. England and S. Scotland," by Mr. P. F. Kendall. Dr. A. Smith Woodward, F.R.S., has promised a paper, but the title is not yet known. There will also be the first report of the Committee appointed at Belfast to report upon the fauna and flora of the Trias of the British Isles. The greater part of this first report is furnished by Mr. Beasley, and deals with footprints.

Zoology.

President.—Professor Sydney J. Hickson, M.A., D.Sc., F.R.S.

Professor Hickson is Professor of Zoology, Owens College, Manchester, since 1894. Honorary Fellow of Downing College, Cambridge. Assistant to Professor Moseley, Oxford, 1882. Travelled in Malay Archipelago, 1885-86. Deputy Professor of Zoology at Oxford, 1888. Lecturer in Advanced Morphology, Cambridge, 1890.

Publications.—"A Naturalist in North Celebes;" the "Fauna of the Deep Sea;" the "Story of Life in the Seas."

Subject of Address.—Professor Hickson, in reviewing the progress of zoology in England since the last meeting at Southport, when Professor Ray Lankester pointed out the inadequate encouragement which existed at that time for original investigators in the science, will point out that even after twenty years none of the Universities, Oxford, Cambridge, or London, have created posts of sufficient value to enable any zoologist to devote himself single-mindedly to such a task. On the other hand, laboratories have multiplied; and the immense importance of such work in ordinary life is beginning to be slowly appreciated by municipalities. The latter part of the address will indicate as the two chief directions of zoological research at present—the study of natural variations, and the problems of their transmission.

Work of the Section.—The most important event in the Zoological Section will be the open discussion on certain problems of fertilisation.

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in which it is anticipated that some prominent botanists will take part. Several papers dealing with the morphology of Cœlenterata have been promised, including one by Mr. Duerden on corals, and one on the physiology of digestion in Alcyonarians by Miss Edith Pratt. Mr. Crossland has promised an address on his dredging experiences in Zanzibar; Professor McIntosh will read papers on a comparison of the terrestrial and marine fauna and on variation in Ophiocoma. Among other papers that will probably prove to be of considerable interest, there is one, by Mr. M. D. Hill, on the nuclear changes in the egg of Alcyonium.

Geography.

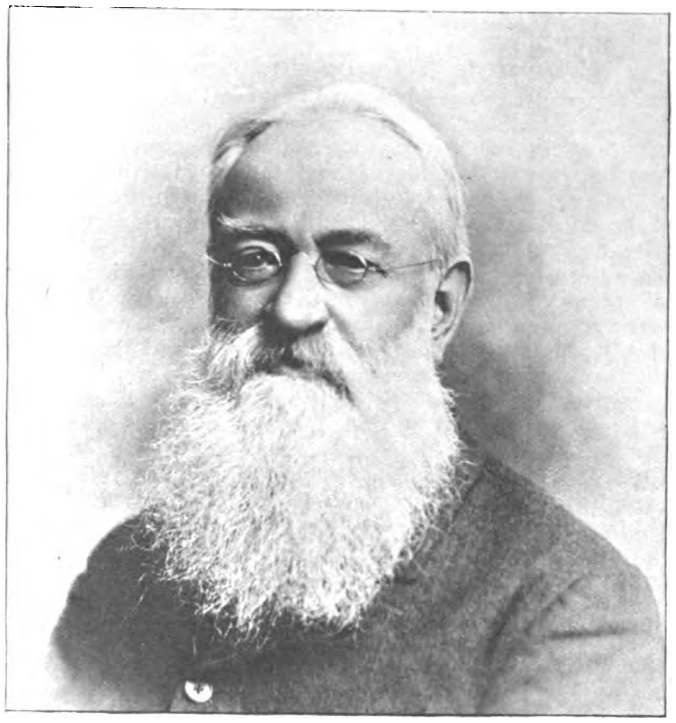
President.—Captain Ettrick William Creak, C.B., R.N. (retired) F.R.S., served afloat in the Royal Navy for several years and during the last Maori War in New Zealand. Was elected to the Royal Society in 1885. Appointed Superintendent of Compasses, Hydrographic Department of the Admiralty, 1887, and on retiring from that office in 1901 was appointed C.B. in recognition of his services therein. Was member of Council of the Royal Society, 1899-1900. He is also a

Captain CREAK. [*Photo by Maull & Fox*

member of the Institution of Electrical Engineers and a Fellow of the Royal Geographical Society.

Subject of Address.—The relations between Geography and Terrestrial magnetism, and the connection of both those sciences with Geology. Of Magnetic Surveys on land and at sea, the secular change in the World's magnetism and on the dependence of many phenomena of Terrestrial Magnetism upon Locality. As travellers on land have done in the past so can they now assist in elucidating the secrets of the world's magnetism. Value of the knowledge of the magnetic elements to modern navigation in iron ships.

The scientific nature of the presidential address is fully reflected in the programme of the general work of the section. In the list of papers, records of journeys of exploration are conspicuous by their absence. Colonel Manifold, indeed, will discuss the Routes to the Yang-tsze Valley, and Mr. J. P. Thomson, founder and secretary of the Queensland branch of the Royal Geographical Society of Australia, has promised to give an account of the geography of Queensland, where he has travelled widely. It is also hoped that Lieutenant Shackleton will be able to contribute a paper on the National Antarctic Expedition, in the first year's work of which he took so prominent a part. But the great majority of papers deal with the more purely scientific branches of geography. An important subject down for discussion by Colonel F. Bailey is the Denudation of Mountains and its Remedy. More or less akin to this is the Afforestation of Waterworks Catchment Areas, a subject which will be dealt with by Mr. J. J. Parry, special attention being paid to the case of Liverpool. A paper of much practical interest to explorers should be that on Improved Methods of Survey for Travellers, by Mr. E. A. Reeves, the Royal Geographical Society's map curator and instructor, while equally interesting and instructive in another direction will be Mr. E. D. Morel's account of the Economic Development of West Africa, a topical subject of special importance. Other papers to be read before the Section are the Geographical Distribution of Disease and Disease Carriers, by Dr. L. Sambon; the Melting of Ice in relation to Ocean Currents, by Professors Pettersson and Sandstrom; the Importance of Echology to Geography, illustrated by slides, by Mr. O. Darbishire; the Physical Geography of the Pennine Chain, by Mr. B. F. Kendall; a Botanical Survey of Westmorland and Cumberland, by Mr. F. J. Lewis: Glareanus, a XVIth Century Geographer, and his manuscript maps, by Mr. E. Heawood; and the Nomenclature of British Mountain



Mr. EDWARD BRABROOK. [*Photo by Lafayette.*

Systems, by Dr. H. R. Mill. A feature of much interest in the proceedings of the Section should be the joint meeting which has been arranged with Section L (Educational Science), for the purpose of discussing the teaching of geography. Mr. H. J. Mackinder, Reader in Geography at the University of Oxford, will open the discussion, and he will be followed by several others who have devoted special attention to this important branch of school work.

Engineering.

President.—Mr. Charles Hawksley, M. Inst. C.E. No particulars of Mr. Hawksley's address, which will be delivered on the 10th instead of the 9th of September, are available at the time of going to press, but the work of the Section promises to be valuable. Friday, September 11, will be mostly devoted to a discussion on the problem of modern street traffic, which will be opened by Colonel Crompton, R.E. If time permit, other papers will be taken on Friday. On Monday and Tuesday, September 14 and 15, the following papers will be discussed:—Refuse Destructors, by Mr. W. F. Goodrich; Natural Gas in Sussex, by Mr. R. Pearson; Water Supply of South-West Lancashire, by Mr. T. Parry; Balancing of Manchester Engines, by Professor Perry; Balancing of Alternators, by Mr. B. Hopkinson; Gas Engine Explosions, by Mr. H. L. Wimperis; Rainfall at Seathwaite, by Dr. Mill; and (1) Cast Iron used for Springs; (2) Alloys Cast in Water-Cooled Moulds; (3) Effect of Varying Stresses on Steel, by Captain H. R. Sankey.

Anthropology.

President.—Professor John Symington, M.D., F.R.S., F.R.S.E. The address of the President, Professor J. Symington, F.R.S., will deal mainly with the significance of variations in cranial form, and will discuss the view recently revived by Professor Schwalbe that the Neanderthal skull belongs to a distinct species of Homo, not *Homo sapiens*. It will also consider the relation between the external and internal form of the cranial wall. Among the papers accepted in physical anthropology are the following:—A Study of the Skulls from Round Barrows, in Yorkshire, by Dr. W. Wright; Papers on Skulls from the Malay Peninsular, by Mr. N. Annandale; and on the Physical Character of the Andamanese, by Dr. Garson; a Note on Grattan's Craniometrical Methods, by Professor Symington; a paper on the Papillary Ridges of the Hand, by Dr. E. J. Evatt; another, by Mr. D. MacRitchie, on a Mongoloid type in N.W. Europe; and important reports on Dr. C. S. Myers's work on the Rank and File of the Egyptian Army, on Dr. W. H. R. Rivers's researches among the Todas, and on Mr. Duckworth's investigations among the Ancient and Modern Populations of Crete. The Committee on Anthropometric Methods has a valuable report, and that on the teaching of anthropology will probably report *ad interim*. Archæology is unusually well represented. Mr. Arthur Evans, Mr. R. C. Bosanquet, and Mr. J. L. Myres offer reports on this year's excavations in Crete; Professor Flinders Petrie and Mr. J. Garstang on recent work in Egypt; Mr. G. Clinch on a megalith at Coldrum, in Surrey, which illustrates certain points in Stonehenge; Mr. Annandale on stone implements from Iceland; Dr. C. S. Myers on the ruins of Kharga in the Great Oasis; Mr. T. Ashby on Roman work at Caerwent; and Mr. Garstang on Ribchester; while the usual report on Silchester excavation may be expected to lead to some discussion. Professor R. S. Conway offers an analysis of ancient Italian place-names, as illustrating the early languages. Professor Ridgeway has a paper on the Origin of Jewellery, and Mr. E. Lovett on the Origin of the Brooch. General ethnography (with the exception of Dr. Rivers's work on the Todas), and folklore and comparative

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religion (apart from Mr. W. Crooke's paper on Islam in modern India) are as yet poorly represented, but this defect will probably be made good before long.

Economic Science and Statistics

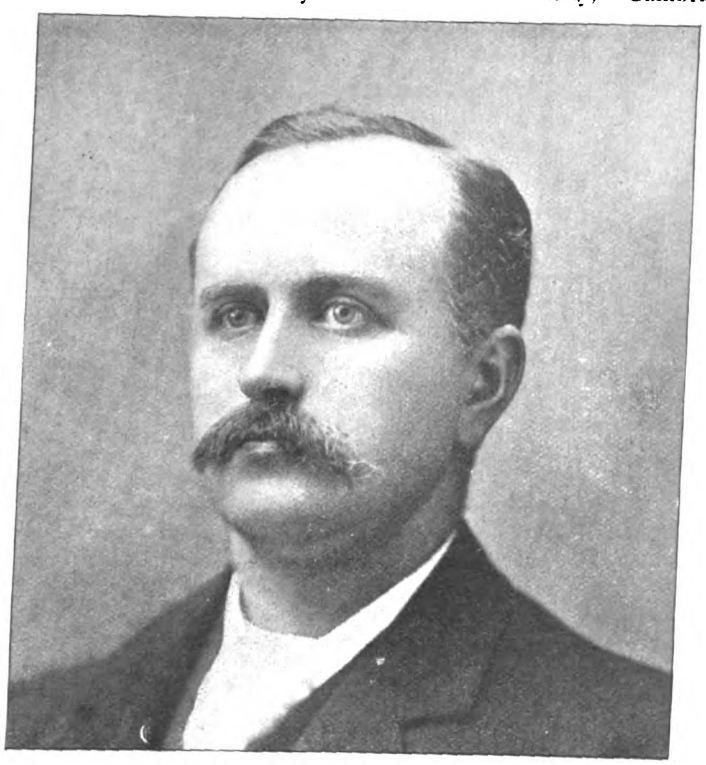
President.—Mr. Edward William Brabrook, C.B., F.S.A., V.P.S.S., V.P.R.S.L. Mr. Brabrook has been Vice-President of the Royal Archæological Institute since 1900; Chief Registrar of Friendly Societies since 1891; President of the Anthropological Institute, 1895-1897; President of Anthropological Section of the British Association, 1898; President of the Folklore Society, 1901-1902; Foreign Associate, Society of Anthropology, Paris.

Publications.—Several Law Books; "Provident Societies and Industrial Welfare," 1898; "History of the Royal Society of Literature."

Subject of Address.—Mr. Brabrook's address will be on "Thrift," a subject with which his thirty-five years' connection with the Registry of Friendly Societies eminently qalifies him to deal. He will review the present position of the "savings" of the nation; and will enquire how far thrift will be affected by Old Age Pensions, and how far the Friendly Societies are to be regarded as proper substitutes for such schemes. The present position of Building Societies will be dealt with; and he will conclude by enquiring, and answering the question, whether the thrift of the nation is or is not to be regarded as progressive.

Botany.

President.—Professor Albert Charles Seward, M.A., F.R.S. F.L.S., F.G.S., University Lecturer in Botany, Cambridge, since 1890. Late Fellow of St. John's College; Fellow and Tutor of Emmanuel College, Cambridge, since 1899. Mr. Seward worked for some time with the late Professor Williamson, of Manchester, and there visited Continental Museums for the purpose of studying fossil plants—a study in which he may properly be described as now the first living authority.



Mr. A. C. SEWARD. [*Photo by Fradelle & Young.*

Publications.—Fossil Plants as Tests of Climate (Sedgwick, May, 1892). The Wealden Flora, Vols. I. and II. (British Museum Catalogues, 1894-95); Fossil Plants for Students of Botany and Geology, Vol. I., 1898. The Jurassic Flora, Part I. (British Museum Catalogue, 1900). Joint-Editor with Mr. Francis Darwin of "More Letters of Charles Darwin" (Murray, 1903).

Subject of Address.—The address (Section K, Botany), deals with the botanical characteristics and geographical distribution of the floras of the past. The flora dealt with are:—(1) The Devonian and Lower Carboniferous Flora; (2) The Permo-Carboniferous Flora, including the Northern or Coal-Measure Flora, and the Southern or Glossopteris Flora; (3) The Flora of the Triassic and Rhaetic periods; (5) Jurassic and Wealden Flora. Special attention is given to the geographical distribution of plant-types characteristic of the vegetation which flourished during different periods in the history of the world. The question of the origin of flowering plants is briefly treated, and a comparison instituted between some of the leading types in the Mesozoic Floras and Genera, which still exist in tropical countries.

Work of the Section.—Miss Ethel Sargant will open a discussion on the evolution of the Monocotyledons, and Professor J. B. Farmer will give a semi-popular lecture on Epiphytes. Mr. W. Bateson will give an account of the new discoveries in heredity, Miss E. R. Saunders will describe the results of some cross-breeding experiments with plants, and Mr. C. C. Hurst will describe some recent experiments on the hybridisation of orchids. Other papers will include an account of important recent advances in our knowledge of algæ, by Messrs. Tansley and Blackman; the sandhill and saltmarsh vegetation of Southport, by Dr. Otto V. Darbishire; on the seedlings of some grasses, by Miss Sargant and Miss Robertson; on willow canker, by Professor T. Johnson; and on some experiments with the staminal hairs of Tradescantia, by Mr. Harold Wager. It is expected that a number of foreign botanists will be present at the meeting.

Educational Science.

President.—Sir William D. W. Abney, K.C.B., D.C.L., F.R.S. Sir William Abney has been Principal Assistant Secretary, Board of Education, South Kensington, since 1899. President, Royal Astronomical Society, 1893-95. President of the Physical Society, 1895-97.

Publications.—Instruction in Photography, 1870; Treatise on Photography, 1875; Colour Vision, Colour Measurement, and Mixture, 1893; Thebes and its Five Great Temples, 1876.

Work of the Section.—The organising committee of this Section has decided to continue the procedure adopted at previous meetings, namely, to confine the discussions to a few broad subjects. It is proposed to devote two days (September 10 and 11) to an organised discussion of school curricula, based on a series of short papers contributed by Professor John Adams, Professor H. E. Armstrong, F.R.S., Miss S. A. Burstall, Mr. G. F. Daniell, Mr. W. E. Fletcher, Mr. T. E. Page, Mr. J. L. Paton, and Professor Michael E. Sadler. A joint meeting with the Geographical Section will be held to discuss the "Teaching of Geography." The discussion will be opened by Mr. H. J. Mackinder, and he will be followed by several gentlemen who have devoted special attention to this important branch of school work. In addition to these subjects, there will also be discussions on the reports of committees on:—(*a*) "The Conditions of Health Essential to the Carrying on of the Work of Instruction in Schools"; (*b*) "The Teaching of Natural Science in Elementary Schools"; (*c*) "The Influence Exercised by Universities and Examining Bodies on Secondary School Curricula, and also of the Schools on University Requirements"; (*d*) "The Teaching of Botany in Schools."

EPITOME OF PROGRAMME.

WEDNESDAY, 9th SEPTEMBER.
12 noon.—Meeting of Council at the Town Hall.
2 p.m. —Meetings of Sectional Committees.
4 p.m. —Meeting of General Committee at the Town Hall.
8-30 p.m. —President's Address in the Opera House.

THURSDAY, 10th SEPTEMBER.
10 a.m.—Meetings of Sections.
3 p.m.—Conference of Delegates of Corresponding Societies.
8-30 p.m.—Reception and Conversazione in the Municipal Buildings, by invitation of the Mayor of Southport, T. T. L. Scarisbrick, Esq.
NOTE.—Applications for Saturday's Excursion Tickets must be handed in on this day by 12 noon at latest.

FRIDAY, 11th SEPTEMBER.
10 a.m.—Meetings of Sections.
3-15 p.m.—Meeting of General Committee.
3-30 p.m.—Garden Party at Hesketh Park, by invitation of the Mayor and Mayoress of Southport.
8-30 p.m.—Lecture in the Cambridge Hall by Dr. Robert Munro. Subject: "Man as Artist and Sportsman in the Palæolithic Period."
NOTE.—Applications for invitations to Sir George Pilkington's Garden Party at Belle Vue, on Monday, September 14th, should be handed in on this day before 12 noon.

SATURDAY, 12th SEPTEMBER.
Excursions.
8 p.m.—Lecture to Working Men in the Cambridge Hall by Dr. J. S. Flett, of London. Subject: "Martinique and St. Vincent: the Eruptions of 1902."
NOTE.—Applications for invitations to Mr. Vernon's Garden Party at Wyborne Gate, Birkdale, on Tuesday, September 15th, should be handed in on this day before 12 noon.

SUNDAY, 13th SEPTEMBER.
Special Sermons at various places of worship.

MONDAY, 14th SEPTEMBER.
10 a.m.—Meetings of Sections.
3-30 p.m.—Garden Party, by invitation of Sir George Pilkington, at Belle Vue, Lord Street West.
8-30 p.m.—Lecture in the Cambridge Hall by Dr. Arthur Rowe, F.G.S. Subject: "The Old Chalk Sea and some of its Teachings."

TUESDAY, 15th SEPTEMBER.
10 a.m.—Meetings of Sections.
3 p.m.—Conference of Delegates of Corresponding Societies.
4 p.m.—Garden Party, by invitation of William Vernon, Esq., at Wyborne Gate, Birkdale.
8-30 p.m.—Reception in the Municipal Buildings, by invitation of the Local Committee.
NOTE.—Applications for Thursday's Excursion Tickets must be handed in by 12 noon on this day.

WEDNESDAY, 16th SEPTEMBER.
10 a.m.—Meetings of Sections.
1 p.m.—Meeting of General Committee in Town Hall.
2-30 p.m.—Concluding General Meeting in Town Hall.
Visits to Works.

THURSDAY, 17th SEPTEMBER.
Visits to Works and Excursions.

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The Foundation of the British Association.

THE origin of the British Association is to be traced to a discussion which arose between the years 1826 and 1831 on the low state of science in England and the neglect of scientific men. Sir Humphry Davy, Sir John Herschel, Sir David Brewster, Professor Playfair had all expressed their deliberate opinion as to the superiority of foreign to British Scientific Institutions, and their strong feeling with regard to the national discouragement given to scientific men in England. An article by Babbage reflecting on the decline of science was reviewed by Brewster in the *Quarterly Review*. Brewster proposed, as a means of reviving and extending British science, that "An Association of our nobility, clergy, gentry, and philosophers can alone draw the attention of the sovereign and the nation to this blot on its fame." He further conceived the idea of holding annual meetings of scientific men, or rather it was suggested to him by the example of Germany, where the "Association of Physicians and Naturalists" had been founded in 1822 by Dr. Oken, of Munich. The first meeting was held at Leipsic for the purpose of making students of natural science and medical men acquainted with each other, and it was attended by but twenty residents in Leipsic and twelve visitors. During the next six years the meetings increased in importance, that of 1827 being held in Munich, and patronised by the King of Bavaria. On the 18th September, 1828, the Congress assembled in Berlin under the patronage of the King, and the presidency of Baron von Humboldt; Mr. Babbage was the only Englishman present, and he recorded his opinion of it in an article in the *Edinburgh Journal of Science*. At a *soirée* given by the President on the same date, 1200 persons were present, among whom was the King of Prussia. In 1830, the year before the founding of the British Association, the German Congress met in Hamburg, and among the 285 visitors from a distance in attendance, were Professor Johnstone, Dr. Traill, Mr. Babbage, and Professor Pillans. Professor Johnstone wrote a full account of it to the *Edinburgh Journal of Science*.

THE INITIAL STEPS TAKEN BY SIR DAVID BREWSTER.

Incited by the success of the German Association, and by some ideas put forth in a work by Mr. Babbage, entitled "Reflections on the Decline of Science, and Some of its Causes," Sir David Brewster determined to start the British Association for the Advancement of Science. He selected York for the first meeting, because it was a central place, possessing a Philosophical Society which had been in existence for eight or nine years, and he wrote the following letter to Mr. Phillips, the Secretary of that Society:—

Allerby, by Melrose, February 23rd, 1831.

"Dear Sir,—I have taken the liberty of writing to you on a subject of considerable importance. It is proposed to establish a British Association of Men of Science, similar to that which has existed for eight years in Germany, and which is now patronised by the most powerful sovereigns in that part of Europe. The arrangements for the first meeting are in progress, and it is contemplated that it shall be held in York, as the most central city of the three kingdoms. My object in writing to you at present is to beg that you would ascertain if York will furnish the accommodation necessary for so large a meeting, which might perhaps consist of 100 individuals; if the Philosophical Society would enter zealously into the plan, and if the Mayor and influential persons in the town and in the vicinity would be likely to promote its objects. The principal objects of the Society would be to make the cultivators of science acquainted with each other; to stimulate one another to new exertions; to bring the objects of science before the public eye, and to take measures for advancing its interests and accelerating their progress. The Society would possess no fund, make no collections, hold no property, the expense of each anniversary meeting being defrayed by the members who are present.

"As these few observations will enable you to form a general opinion of the object in view, I shall only add that the time of meeting which is likely to be most convenient would be about the 18th or 25th of July.—I am, dear Sir, ever most truly yours,

"D. BREWSTER,"

"J. Phillips, Esq."

The Philosophical Society and the Mayor and Magistrates of York received the proposition favourably; so also did the Archbishop of York, who offered hospitality to the leading members of the Association at his palace. Among the scientific men who warmly supported Sir David Brewster in the undertaking from the first were Sir Roderick Murchison, Mr. Robison, Mr. Forbes, Professor Johnstone, and Professor Phillips. The month of September was finally fixed upon as the best for the holding of the opening meetings.

The following were the first officers of the British Association:—President: Charles William, Viscount Milton, F.R.S., President of the Yorkshire Philosophical Society. President elect: The Rev. William Buckland, D.D., F.R.S., Professor of Geology and Mineralogy, Oxford. Vice-President: The Rev. William Vernon Harcourt, F.R.S., Vice-President of the Yorkshire Philosophical Society. Vice-Presidents elect: Sir David Brewster, LL.D., and the Rev. William Whewell, F.R.S., Professor of Mineralogy, Cambridge. Treasurer: Mr. Jonathan Gray, of York. Secretaries: York—Mr. William Gray, jun., and Mr. John Phillips, F.G.S., Secretaries to the Yorkshire Philosophical Society; London—The Rev. J. Yates, F.L.S.; Edinburgh—Mr. J. Robison, Secretary to the Royal Society of Edinburgh; Oxford—Mr. Charles Daubeny, M.D., and the Rev. Baden Powell, F.R.S. The Association started with about 250 members, among whom were Dr. Abercrombie, Mr. Babbage, Sir D. Brewster, Dr. Christison, Mr. John Dalton, Mr. Charles Daubeny, Sir Philip Egerton, Sir John Forbes, the Rev. W. Vernon Harcourt, Mr. Charles Lyell, Mr. R. J. Murchison, Mr. John Phillips, Sir Thos. Phillips, the Rev. W. Scoresby, Sir John Sinclair, the Rev. W. Whewell, and Sir Alexander Wood.

THE FIRST MEETING.

The opening meeting of the Association was held in the theatre of the Yorkshire Museum, on Tuesday, the 27th September, 1831; rather more than 300 persons were present; the total number of tickets which had been issued was 353. The meeting began at twelve o'clock at noon. On the motion of Dr. Brewster, Viscount Milton was voted into the chair, from which he gave a presidential address of five minutes' duration. He expressed a hope that the Association would be a useful body, and that from a small beginning it might rise into importance. He hoped it would remove obstacles to the progress of science. For instance, the fiscal laws of the country offered obstacles to scientific improvements; the regulations relating to the manufacture of glass greatly hampered the progress of the science of optics. The Rev. Wm. Vernon Harcourt, chairman of the Committee of Management, then said a few words to the effect that the Association was formed upon the model of one which had existed in Germany for several years. After Mr. Phillips had made a statement about the number and nature of the invitations to attend the meetings which had been sent out, Mr. Vernon Harcourt read extracts from the letters of those who could not attend, including one from Mr. Faraday, who put forth the plea of pressing engagements elsewhere. Mr. Harcourt next explained the plan of action which had been laid down for the Association, and its proposed constitution; he also incidentally described the founding of the Royal Society, which originally was a kind of college. Dr. Brewster, Mr. Roderick Murchison, Dr. Pearson, and Mr. Robison also spoke to various resolutions proposed at the meeting. It was resolved unanimously: "That an Association be formed, to be called the British Association for the Advancement of Science, the objects of which shall be to give a stronger impulse and more systematic direction to scientific inquiry, to promote the intercourse of those who cultivate science in different parts of the British Empire with one another, and with foreign philosophers, and to obtain a greater degree of national attention to the objects of science, and a removal of any disadvantages of a public nature which impede its progress."

THE FIRST SECTIONAL WORK OF THE ASSOCIATION.

The sectional work began before the Association was actually formed. The opening meeting just described was held on a Tuesday, yet the preceding day—Monday—Professor Phillips had given an account of the most remarkable phenomena in the geology of Yorkshire. On the Tuesday nearly all the time was occupied in the formation of the Association, but a part of a letter from Mr. George Harvey, F.R.S., was read, on "The Geometrical Analysis of the Ancients." On Tuesday evening, Mr. Abraham delivered a lecture on magnetism, and exhibited his magnetical apparatus for protecting the eyes and lungs of the Sheffield grinders from particles of steel. On Wednesday, Dr. Brewster communicated a paper on mineralogy, and an essay by Dr. Henry on "The Philosophical Character of Dr. Priestley," was read. On Wednesday evening Mr. R. Potter, jun., read a description of his new construction of a reflecting microscope. On Thursday morning, Mr. Dalton read a paper "On Food and its Influence on Secretions," after which Mr. R. Potter, jun., came to the front again with some remarks on one of Fresnel's theories about light. The place of abode of the active Mr. Potter was Smedley Hall, Manchester. On the same day Mr. William Hutton read a geological memoir, and Mr. Roderick Murchison criticised the same. Mr. Johnston described vanadium and its ores, Mr. Witham read a botanical paper, followed by a note by Dr. Henry on the yellow copper pyrites of Anglesea. On Thursday evening Mr. Scoresby gave an experimental lecture on magnetism, and finished it on Friday morning. On Friday, also, Dr. Brewster read a paper on the crystalline lens in the eyes of various animals, and Mr. Murchison spoke on the geology of Preston. Dr. Daubeny spoke of hot springs and volcanos. On Friday the indefatigable Mr. Potter, jun., described some experiments on electrical discharges in vacuo, and Dr. Warwick, Dr. Daubeny, and Mr. Osborn communicated items of interest. On Saturday Mr. Dalton described some physiological observations, Mr. Allan described a beryl belonging to Don Pedro, Mr. Robison described his linseed oil barometer, and Mr. Forbes read an essay on the barometer. Sir James South sent in a communication on the satellites of Jupiter. On Saturday evening Dr. Daubeny called attention to experiments with coal gas, and the Rev. W. Vernon Harcourt exhibited a lamp constructed upon a new principle. Dr. Brewster contributed an essay on spectrum analysis, and Professor Gazzari another on detecting traces of writing which have been fraudulently erased.

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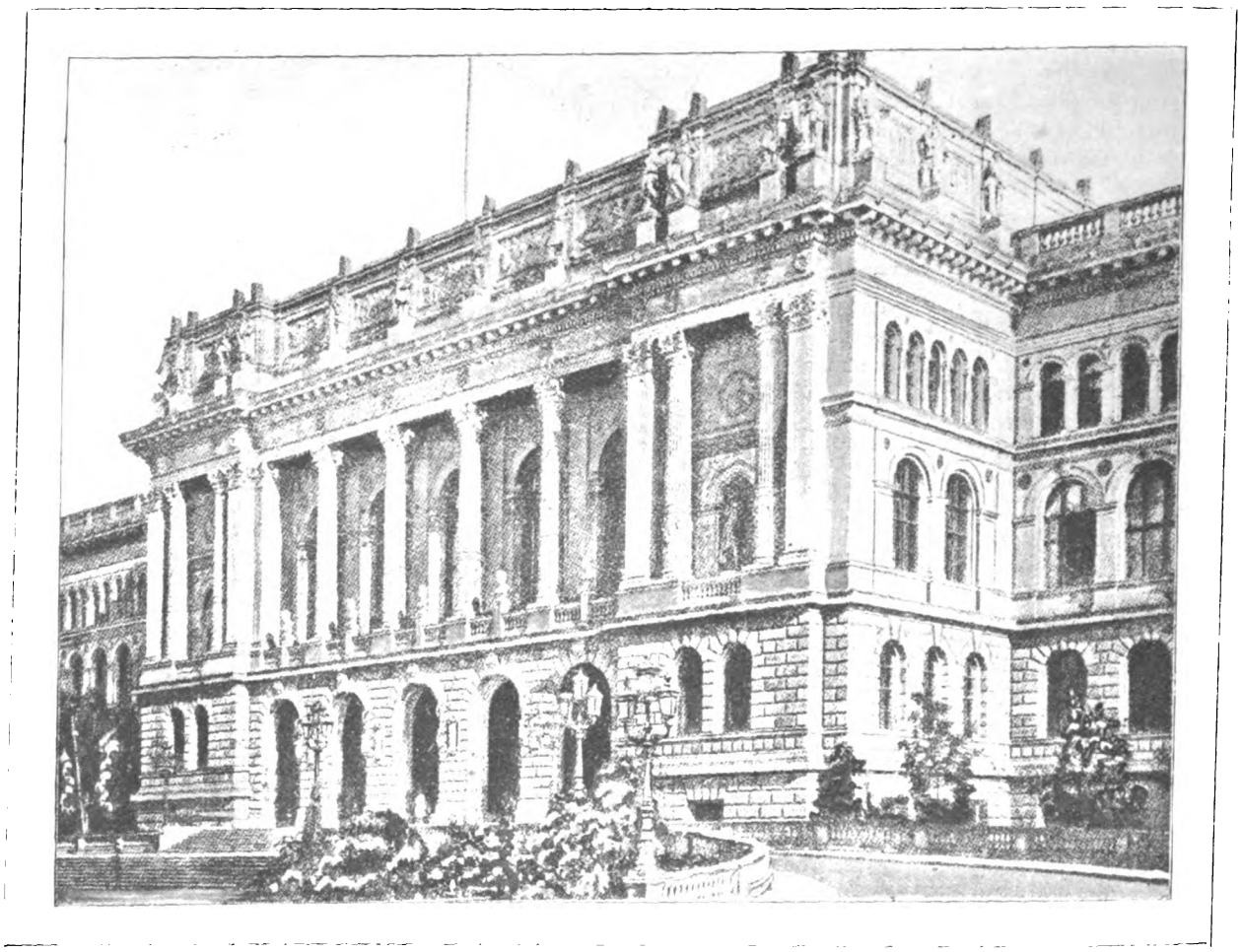
Charlottenburg.

"To my mind the really appalling thing is not that the Germans have seized this or the other industry, or even that they may have seized on a dozen industries. It is that the German population has reached a point of general training and specialised equipment, which it will take us two generations of hard and intelligently directed educational work to attain. It is that Germany possesses a national weapon of precision, which must give her an enormous initial advantage in any and every contest depending on disciplined and methodised intellect."—*Professor Dewar's Presidential Address to the British Association, Belfast, 1902.*

A conspicuous testimony to the absence in England of that "national weapon of precision," the possession of which Professor Dewar attributes to Germany, is to be found not in the fact that Lord Rosebery should have proposed the foundation of an English Charlottenburg, but that the proposal should have aroused so little interest, and should have been so soon forgotten. The real "national weapon of precision" which Germany and the United States possess in common is a settled belief in the advantage which science can confer on manufacture. Not so long ago a great American astronomer was lamenting that in the United States no such honour was paid to men of science as in England, but that the whole appreciation of a man's work in America depended on the commercial use to which it could be put. That may not be a very satisfactory state of things from the astronomer's point of view—but it is extremely advantageous to the progress of manufactures. In the United States, as in Germany, it is the manufacturer who seeks the aid of science: who pays for science. In England science is still regarded as something outside the other interests and activities of life and progress. A Northern manufacturer, who was once asked to give a boy employment, responded that the boy must "first prove his-self." That is the usual attitude in England towards science. It must first "prove itself"; and then, when the utility of its inventions can no longer be denied, they will be accepted.

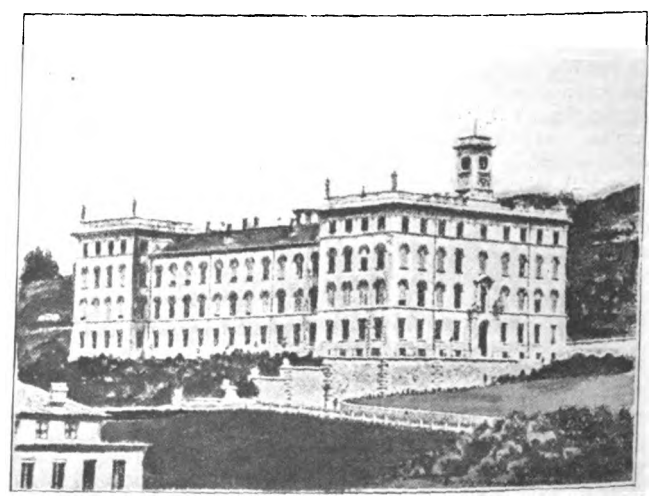
This is rather a long preface to a description of Charlottenburg, the institution on which Lord Rosebery desired that the new English Technical High School should model itself; but it may be held to be not without justification when we remember that Charlottenburg has been "proving itself" for more than a generation. Charlottenburg consists of the "Royal Technical High School" and the "Physikalisch-Technische Reichsanstalt"—which is a vast series of Imperial laboratories, solely used for carrying out researches in pure and technical physics. In a paper which Professor Ayrton, F.R.S., read some years ago, he pointed especially to the work which was being done under the direction of Dr. Loewenherz, aided by forty-six assistants, in these laboratories. In electrotechnics alone there were published from these laboratories original researches on such subjects as "Hardening Steel Magnets," "Standard Resistance Coils for Large Currents," "Photometric Investigations," "Alloys for Resistance Coils," and so on. Some such work as this is done at Bushey Park, and some of the great teaching colleges of London, such as University College, King's College, the City and Guilds Technical College, the Royal College of Science, do, through their Professors and more advanced pupils and assistants, publish papers of original scientific research. But there is, if we except Bushey Park, no institution solely for research; and there is no institution which does things on the same scale as the Reichsanstalt at Charlottenburg; or, to take another example, on anything approaching the scale of the Physical Laboratories under Professor Weber at Zurich.

But even as a technical high school, Charlottenburg claims a striking superiority over anything that we have in England to set beside it. It has nearly 5,000 students. The exact number last year was 4,811, of whom 472 received their education free. Of the total, 843



The Charlottenburg Technical High School.

attended the school of architecture and design, 687 the classes of instruction in civil engineering, building, and construction, 2,026 the department of mechanical and electrical engineering, 381 the marine and naval engineering classes, 400 the classes and laboratories of the chemical department, and sections from all these specialised depart-



The Zurich Laboratories.

ments attended the classes in general knowledge—the scope of which may be gathered from the names of some of the subjects taught there:—Higher mathematics, magnetics, electrotechnics, instrument measuring, mechanics, analysis of gases, physical optics, graphical statics, political economy, and hygiene. It is unnecessary to go into details of all the subjects taught in the specialised branches of instruction, and one cannot well say more than that the curriculum is of German completeness, and that the pupils who go there do not go to learn a smattering, but have to sit tight to the work, and work all day, under the eyes of professors whose numbers are the most striking testi-

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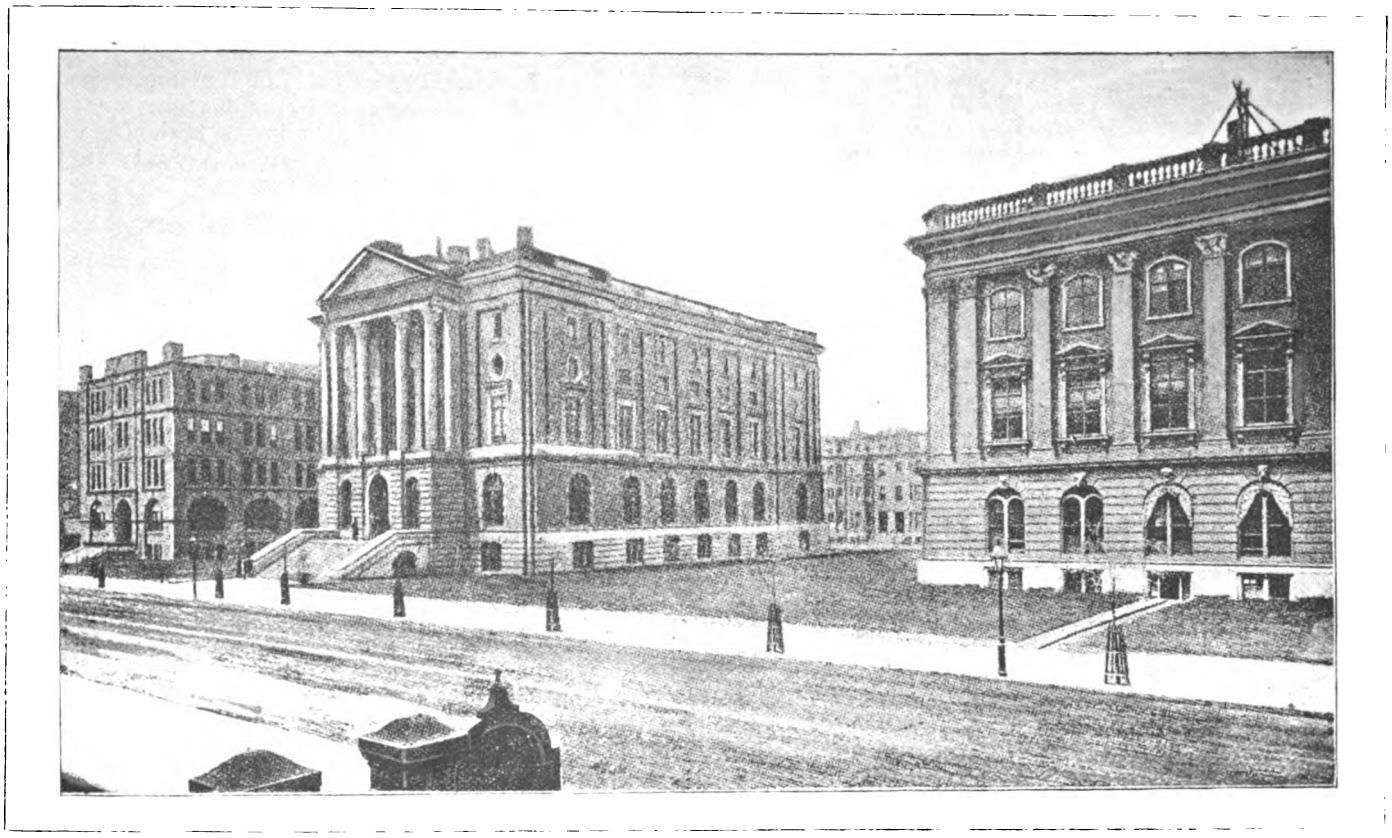
mony to the completeness of the organisation. There are, under Professor Kammerer, the head of the Charlottenburg Technical High School, which was founded in 1883, and so has given Berlin a start of twenty years over London—not to speak of the impulse which it gave to the foundation of similar colleges all over Germany—no fewer than eighty-eight professors and sixty-nine assistant professors. Of the professors twenty-one teach architecture, twelve building and construction, eighteen various branches of mechanical and electrical engineering, six naval and marine engineering, fourteen chemistry, and seventeen "general knowledge."

Accompanying this article is a photograph of the facade of the Charlottenburg Technical School. Compare it with the very best school of the kind we have in London, the Central Technical Institution in Exhibition Road. It is five times as large, cost four times as much to build, and has more than four times as much spent on its yearly maintenance. We have purposely compared these two institutions, rather than put forward one of our polytechnics or new provincial universities for purposes of comparison, because the basis of comparison is better justified. And that is because in the first place there is a tendency in Germany at present to distinguish the Technical High Schools—of which Charlottenburg is but one of ten, all equal in importance—from the universities. The Technical High Schools are erected, not in the small provincial, "residential" towns, like Bonn, but in manufacturing centres, such as Aix, Dantzic, Breslau. They all exist in towns with populations over 100,000, and the aim is to distinguish them and their teaching from universities and university courses. They aim, as the first efforts of the City Guilds aimed, under Professors Ayrton, Armstrong and Perry, to turn out scientific workmen, not accomplished students. In another thing these Technical High Schools find an analogue in the Central College in Exhibition Road. The men who go there have to be workers in a double sense. A stiff entrance examination fences off the ignorant and the idle. In Germany they are not playing with the scientific education of the workman. They have, in short, realised that the important things in life now are not transacted necessarily in the world of politics, but are in the world of knowledge, of engineering, of discovery, and invention.

For a further basis of comparison, photographs of two other technical institutes are appended to this article—both of them nearly twenty years old; both with twenty years' start of the competition we are inaugurating now. One is the Massachusetts Institution of Technology at Boston, U.S.A.; and the other the splendid assemblage of physical laboratories at Zurich. The laboratories at Zurich number fifty-two; and are for experiments on heat, light, radiation, exact electrical measurements of resistance, current, potential difference, capacity; five laboratories for electrical researches; fifteen for electrotechnics. These laboratories are, in fact, for physics alone. A survey of such institution, indeed, and of the many other great efforts which our foreign competitors are making in the applications of science is, indeed, depressing. But we have, at any rate, made a start; and this rather melancholy summary may, perhaps, end on the note which was struck by Professor Perry at the same meeting as that at which Professor Dewar delivered his warning: "If England has always been the last to begin reform, she has always been the most thorough and steadfast of the nations when once she has started on it."

E. S. GREW.



The Massachusetts Institution of Technology.

Cement Poles for Telegraphic Lines.

IT was said some time ago that the demand for poles to carry overhead wires was outrunning the supply, and that this circumstance was more serious than the unsuitability, frequently discovered, of wooden telegraph poles to tropical countries. The ravages of wood-boring insects in some parts of the world have made wooden poles impossible, and the substitution of tubular iron, besides involving great difficulties of transport, has not always been attended by the happiest results, because in those parts of the world where predatory insects abound there are frequently other native inhabitants for whom cheap iron has irresistable attractions. That being so, telegraph engineers may find reason some day to welcome the invention of a Turin engineer, Signor Porcheddu, who has had constructed poles of reinforced concrete. The poles, 36 ft. long, and a section varying from 13½ ins. at the bottom to 6½ ins. at the top, were designed to resist a pull of 440 lbs. applied at about 30 ft. from the ground. The Northern Italian Electric Company subjected the poles to tests of great severity, and examined the poles with respect to their electric resistance, as well as their elasticity. In the respect of elasticity some of the results shown by the cement poles were extraordinary, and they proved also to have a power of resisting strain equal to as much as 3,000 lbs. and 4,000 lbs. Such a combination of resistance and elasticity, combined with the practical absence of cost of maintenance, ought to ensure a future for the concrete telegraph pole.

Hardened Milk.

AT the Hygienic Milk Supply Exhibition, lately held at Hamburg, some objects were exhibited which had, says the *Morning Post*, nothing whatever to do with pure milk. There were shown, nicely arranged in glass boxes, combs seemingly made of horn; cigarholders, with amber-coloured mouthpieces; knives and forks, with black or white handles; a small table with an inlaid "marble" top; and, finally, a number of thick slabs and staves with imitation-marble colours, but of much less weight than marble. These objects were made of "milk stone"—"galalith." Galalith is a waste product of milk. Skimmed milk, though denuded of its most nutritious property, contains a large quantity of casein, and it is out of casein that "milk stone" is made. Fresh casein, which may otherwise be described as dried curds, is dissolved in hot soap-water. To this solution the required colouring ingredients and a metallic salt are added. The result is a firm substance consisting of casein and metallic soap, which by drying and pressing into moulds can be given any required shape. This is but the roughest sketch of a method which has been reached after many experiments and many difficulties, and which is now protected by many patents. The finished product resembles celluloid in several respects, but it has the great advantage of being much less inflammable, and is said to be entirely without smell. Trials have proved that even when kept for weeks in water it distends very little, and it is hoped that by the addition of vegetable oils it may be converted into an insulating material for electro-technical purposes.

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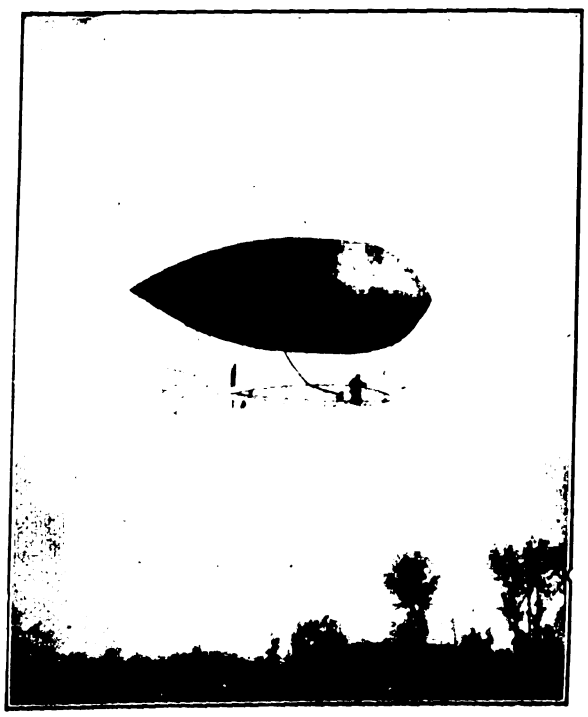
Progress with Airships.

By MAJOR B. BADEN-POWELL, Scots Guards.

THE advent of a really practical machine for accomplishing the navigation of the air is awaited with much interest, and the somewhat meagre and unreliable information that one can pick up from the daily Press is apt only to increase our anxiety to know what is really being done in this line. In the *Illustrated Scientific News* of June, I gave a brief sketch of the history of mechanically propelled balloons, and what had been accomplished up to recent years. During this summer some distinct progress has been achieved in this line.

Santos Dumont No. 9.

M. Santos Dumont has, of course, been well to the fore, and though he has only been using his little No. 9 balloon, which may be likened to a motor bicycle as compared to a large motor car, yet he has been able to steer this apparatus and drive it about so easily that the accounts of his trips read as if practical aërial navigation had been achieved. But, so far as his particular performances go, we are still some way from this. It has only been during the calmest of weather that he has dared to venture forth, for his little 3 horse-power engine is incapable of propelling the vessel at any great speed. This machine is of a pointed ovoid shape, the length being 49 ft. and the greatest diameter 18 ft. This compact form gives better stability if it detracts from speed. The volume of the main gas vessel is 9,200 cubic feet, but this does not imply that so much gas is available for levitation, for of this 1,566 cubic feet is occupied by the "ballonet," which is kept partially full of air by a



Santos Dumont No. 9.

ventilating fan, so as to keep the whole balloon tightly distended. Along each side of the balloon a strip of canvas is sewn in which is enclosed a number of short battens of wood and, from slings attached to these, some 46 steel wires depend to support the frame. The latter, which is 29 feet long, is composed of pine rods of triangular section braced with steel wires and kept apart by wooden triangles of varying size. Towards the front of this frame is the little basket car in which the aeronaut stands, and to the afterside of this is fixed the motor. This is a Clement double-cylinder, air-cooled, petrol engine, weighing but 26·4 lbs. and developing 3 horse-power, or less than 9 lbs. per horse-power. The fly-wheel is formed of a bicycle wheel, which weighs under 2 lbs., and makes 1,600 revolutions. The steel shaft runs back from the motor to the propeller in rear. This is two-bladed, formed of steel tubes, covered with tightly-stretched oiled silk. The propeller is 10 feet in diameter and 15 inches in greatest width. It weighs 24 lbs. and makes 200 revolutions per minute, giving a thrust of 50-60 lbs. The balloon itself weighs only 30 lbs. and the whole apparatus, with framework, car, motor, &c., is under 200 lbs. A tapering trail-rope, 100 feet long, hangs from the front of the balloon and is supported by a pulley under the rear end of the frame, so that the balance can be regulated. A large rudder, of 85 square feet is placed under the after end of the balloon.

Santos Dumont No 10.

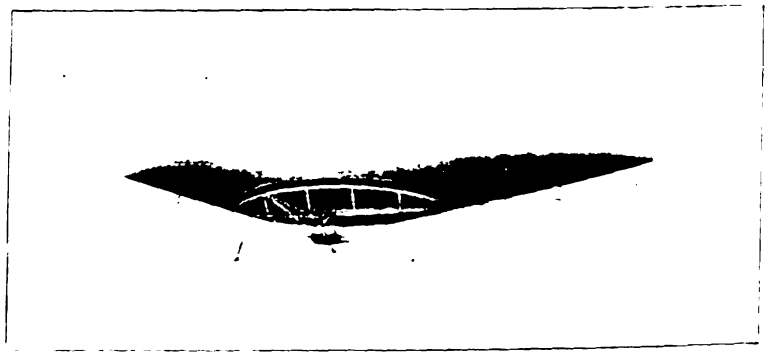
The large Santos Dumont No. 10, the "Omnibus," of which a good deal has been heard, has not yet left its shed. Though it has been practically ready for some weeks there seems to be some doubt as to how it may behave, and with so large a machine it does not do to run any risks. This new machine is far bigger than any of this aeronaut's former balloons, being nearly 200 feet long, and having a capacity of about 70,000 cubic feet. It is supposed to take 14 passengers who are carried in three baskets hung below the long frame. The vessel is to be propelled by two screws, one at each end of the frame, and these are driven by a motor of 60 horse-power. A number of horizontal aeroplanes are arranged between the frame and the balloon, to aid in raising and lowering the apparatus.

Spencer's Balloon.

In England we have also had an experiment with an airship. Mr. Stanley Spencer constructed a new balloon, 93 feet long and 24 feet maximum diameter, containing 30,000 cubic feet. Below this was suspended a framework, similar to that used in the Santos Dumont balloons, 50 feet in length, and stayed 4 feet apart by triangles of bamboo. The engine was a Simms motor of 24 horse-power. A screw propeller, 12 feet in diameter, was placed in front, and a large rudder behind. On its first trial, however, the machine did not prove a success, failing to lift. We may look forward to a better result in future experiments.

Deutsch's Balloon.

Another large machine which is practically ready, and has been for some time, but which also seems to hesitate about starting on its maiden voyage, is the "Ville de Paris," belonging to M. Deutsch and designed by M. Tatin. The general design of this vessel is very much the same as that of M. Santos Dumont, but it has one or two peculiarities worth noting. Instead of the ordinary net, the balloon is covered with a "chemise" of unvarnished silk, to the lower edges of which a continuous boarding is attached. A square rudder is placed in rear, suspended from the end of a triangular framework. The screw, of the same form as the Santos Dumont, is 22 feet diameter.



View from Below.

Lebaudy's Balloon.

But of greater interest still is the airship of Messrs. Lebaudy, which is kept ready inflated in its shed at Moisson. This is probably the most successful aërial machine ever made; it has now accomplished twenty-nine voyages, in all of which, with one exception, it has successfully returned to its point of departure. As comparatively few details have been hitherto published about this machine, it may be interesting to give some. The gas vessel is long and finely pointed at the ends, and contains 80,000 cubic feet. It is composed of two thicknesses of cloth with a layer of india-rubber in between, and the whole is painted bright yellow. The arrangement, designed by M. Julliot, is quite different to that adopted by so many other inventors. There is no long framework suspended below the balloon, but the lower surface of the latter is made flat, and a frame of steel tubing surrounds this plane. From the front part of this, six steel tubes run diagonally down to the car, so as to convey the thrust of the propellers to the balloon, the car being supported by a number of steel-wire ropes. Below the plane is arranged a keel, consisting of a framework of steel tubing, covered along the after half of it with canvas. This keel is continued far away to the rear, where it ends with the rudder. Under the flat part of the balloon is a layer of uninflammable material, and all the portion above it is occupied by the air-filled ballonet, so that there is very little danger of the gas becoming ignited from the engines. The two safety valves, to ease the pressure of the gas, are also placed well out of reach behind.

The car consists of a boat-shaped frame of steel, partially covered in at the sides with canvas, the after-part being left open, so as not to offer any resistance to the air. The engine, a Mercedes, of 40 horse-power, is placed in the centre, the shaft running horizontally across and geared at right angles to the two propellers. The latter are 2 m. 44 in diameter, and each consists of a steel bar, to which is fixed a thin plate of steel of a width equal to one-sixteenth of the circumference. These comparatively small propellers rotate at a considerable speed, about 1,000 turns per minute.

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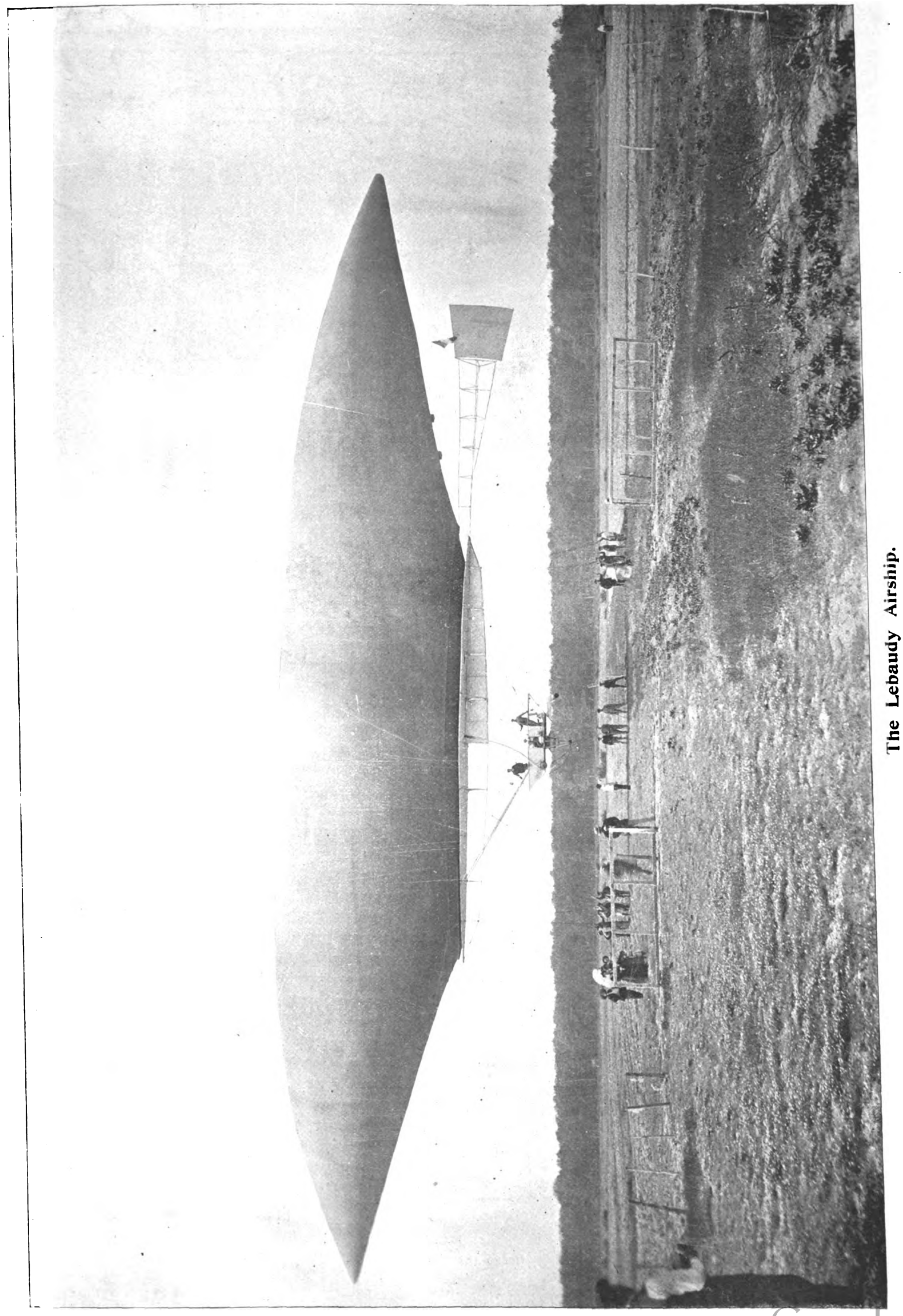

The Lebaudy Airship.

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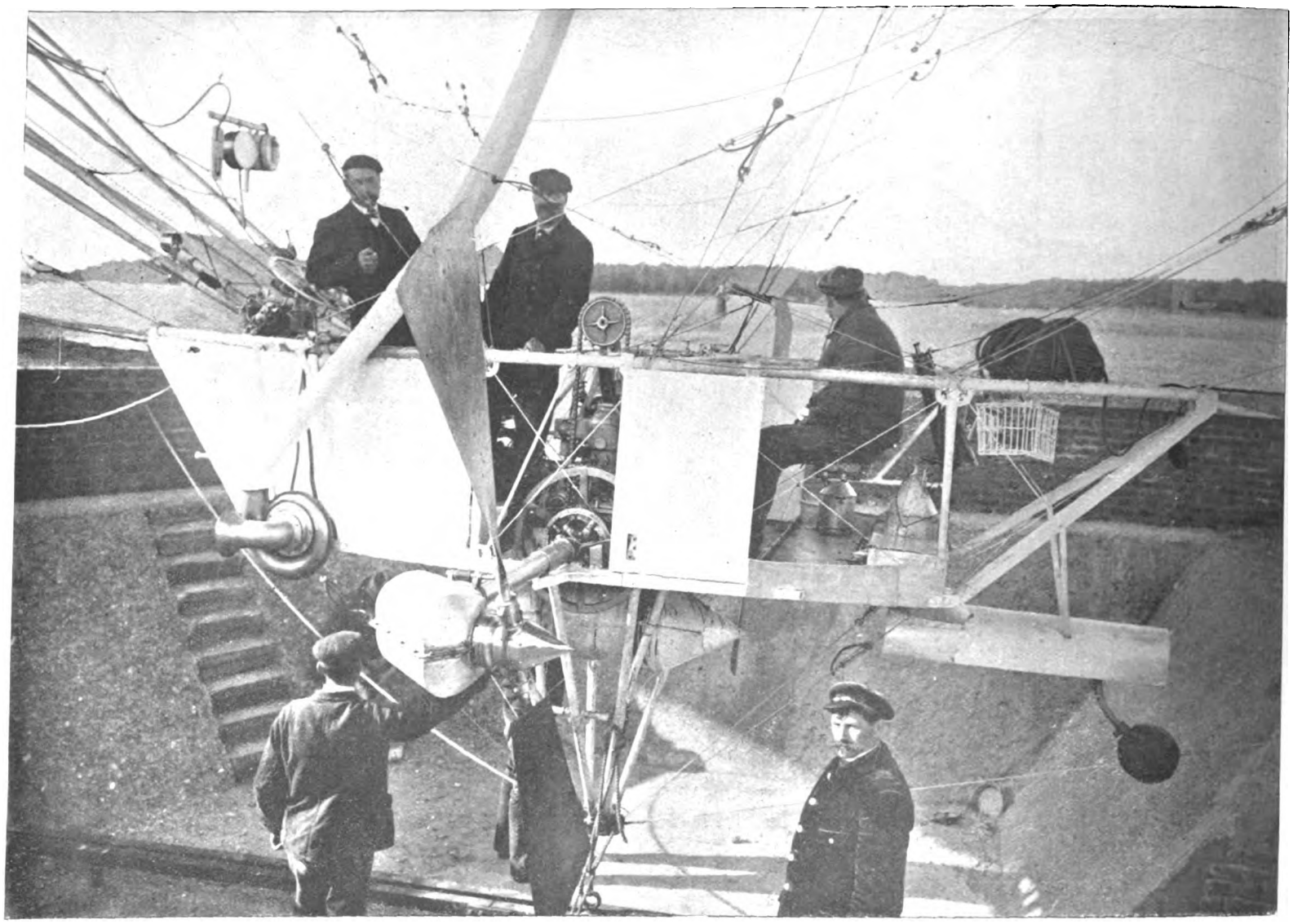
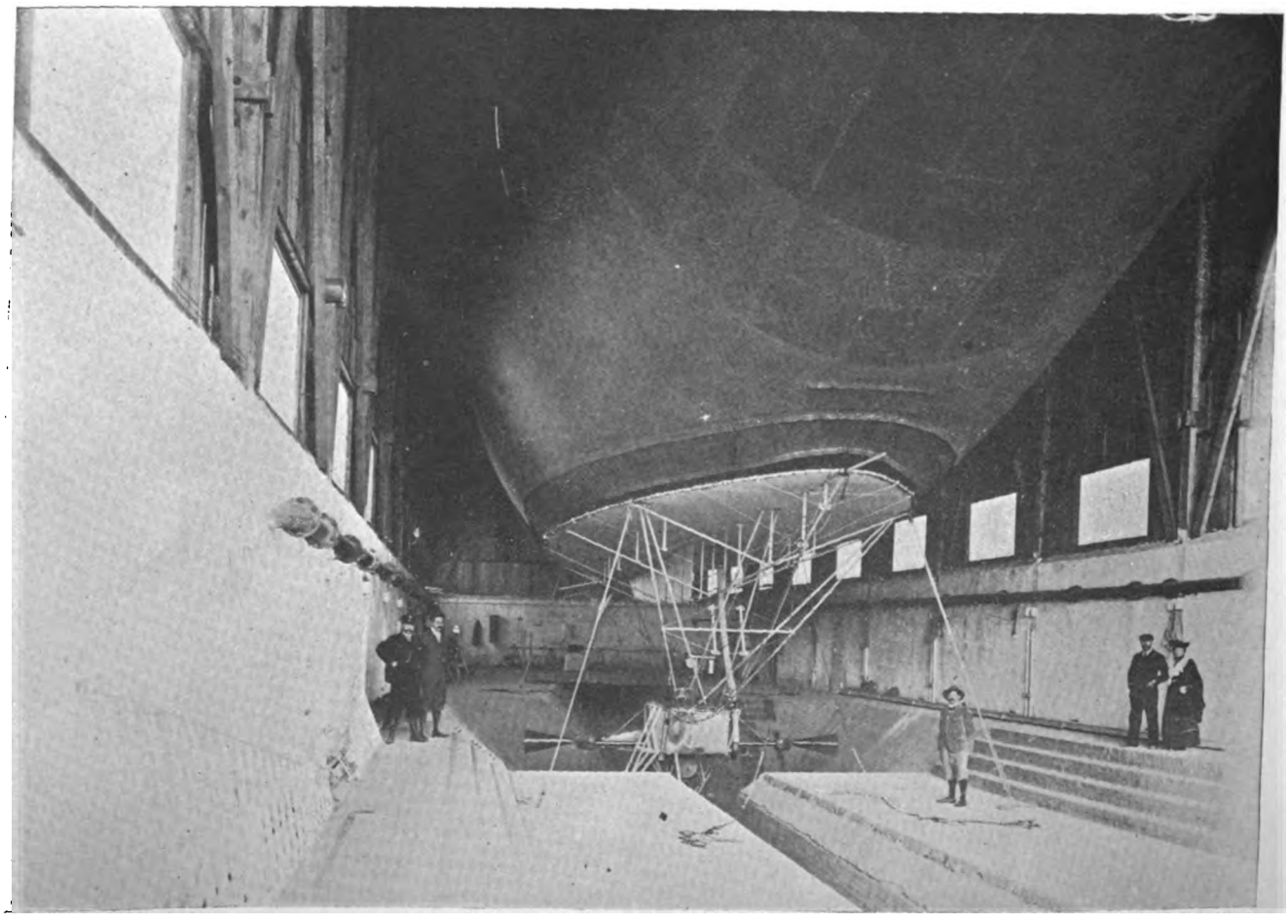
In the front part of the car, where the aeronaut in charge stands, may be seen the steering wheel, similar to that of a motor-car. This is connected by means of an endless chain and wires to the rudder. Above this are the pressure gauges to show the compression of the gas and of the air in the ballonet. To the aeronaut's left, (in the photograph he is turned about), is the ventilator fan, driven by a belt from the engine, which drives air through the pipe up into this ballonet. To his right is a metal funnel, continued below the car, in which to empty the sand ballast, so as not to allow any dust to get into the engine. The engineer sits in rear of the motor, and here is to be seen another of the precautionary measures which are so abundantly provided. The white square seen in the photograph in front of the engines is a thin plate of metal to protect the engineer in case of anything going wrong with the screw, a detached portion of which, travelling at so great a speed, might do much damage. Below the back of the car is the exhaust from the engine [illegible]



The Car of the Lebaudy Airship



Inside the Shed.

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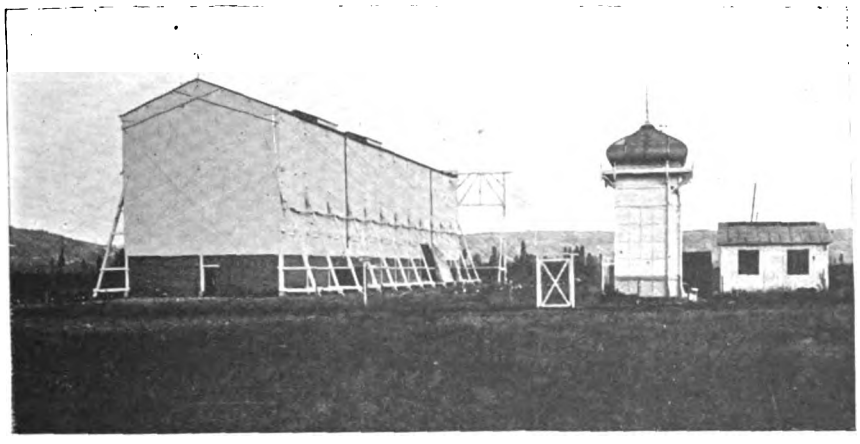
ing of which is enclosed in a ball of wire gauze. A store of oil to last 15 hours is carried under the car. A small extincteur is carried in case of fire.

It is with some surprise that one notices how very strongly and solidly all these parts are constructed. Aluminium is conspicuous by its absence, everything is made of steel, and there seems no attempt to make it specially light.

The entire weight lifted by the balloon, including passengers, is given as 5,700 lbs.

The shed in which this enormous vessel is housed is also very well constructed. It is of wood, well stayed and trussed, with huge doors across one end. The floor is cemented, a well being made in the centre for the car to rest in. The arrangements for guiding the airship out of the shed are very neat. Along each side of the hall, and along the centre, run double rails close together. Four guy-ropes depend from the balloon, two on each side. These end with an iron ring and ball, which ball is gripped by the rails, a similar



The Lebaudy Shed.

ball is attached to the bottom of the car and is held by the third pair of rails. When the vessel is to be taken out, a man stands to each of the rings and slides it along the rails. The rails are continued outside the building, so that even when the machine is well outside, it is still secured by the guys. When all is ready to start, the ropes are detached from the rings and the balloon is free.

As regards the journey actually made, the first proper ascent was effected on April 11, when the machine rose at 8.15 a.m. and remained up for half an hour, covering in that time 19 kilometres. Later in the same day it made a second ascent, and stayed up for an hour. On May 8 an important journey was made, the airship proceeding to the town of Mantes, 10 kilometres distant, where it went through various evolutions, went on to Rosny, and then returned to its shed at Moisson, completing altogether some 23 miles in an hour and a half. On a later occasion even this record was beaten, the machine going a journey lasting two and three-quarter hours, and traversing over 61 miles. These trips were not, apparently, made during the most favourable weather, for on the journey to Mantes it was said that rain, accompanied by a considerable wind, prevailed.

The greatest speed recorded is 11·80 metres per second (or over 25 miles per hour). Ascents have been made at all times of day, from 4 o'clock in the morning to 8 o'clock at night, even in fog and in frost. The balloon has recently remained for 196 days inflated. The ascents were all conducted by the aeronaut, M. Juchmes.

Barton's Balloon.

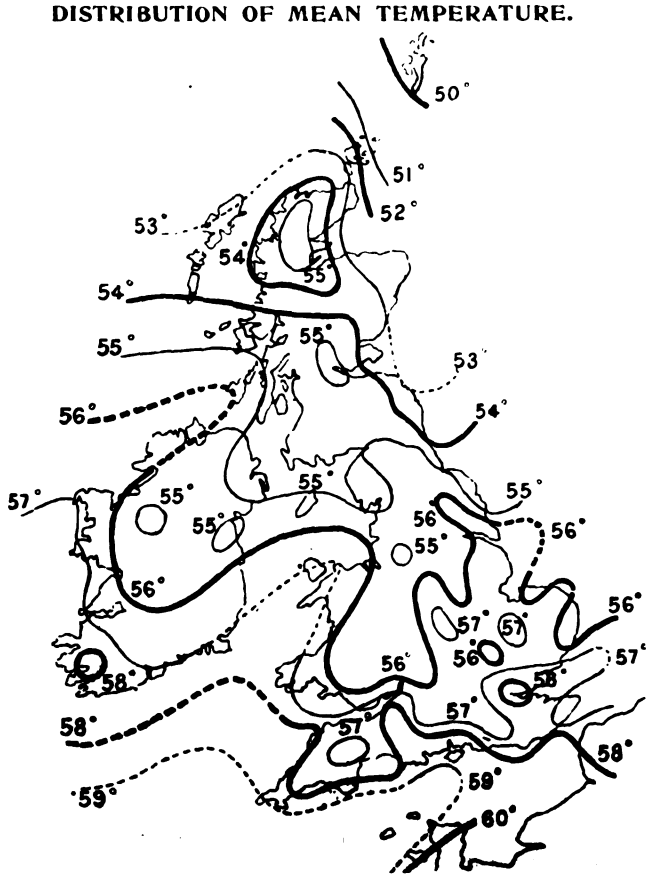
Another large airship which, though it has not at the time of writing yet made an ascent, should be nearly ready for its initial trials. This machine is very different in design to those I have just described. The shape of the gas vessel is to be somewhat like that of a shell, that is to say, cylindrical, with an ogival head and a blunt stern. Schwarz's balloon was roughly of this shape. It is composed of well varnished silk, and will have a "chemise" of similar fabric unvarnished to go over the top instead of a net. Portions of the envelope, especially at the head, are stiffened with bamboo ribs. The balloon is about 170 feet long and some 50 feet in diameter. Underneath this is suspended a huge framework of stout bamboos, lashed together and trussed with wire stays. This is 140 feet long, and supports a deck which can be walked along from end to end. There are three separate engines, each of 50-horse power. There are to be three pairs of propellers, each having several superposed blades. One of the main features of the apparatus is a series of aeroplanes, which are to assist the horizontal stability and the raising and lowering of the machine. The whole airship is very big and cumbersome, but it has very powerful engines. If anything should go wrong with the latter, however, it will be a difficult balloon to manage.

Other Airships.

An enormous machine is being constructed in San Francisco for Mr. Stanley. It is to be made almost entirely of aluminium. The shape is cylindrical, with conical ends, and it is 228 feet long. Propellers are to be fixed at each end as well as on the top, the latter being to regulate the rise and fall. It is supposed to take "at least 30 passengers." Another machine, but of more ordinary dimensions, is nearing completion in London. Mr. Beadle, the inventor, proposes to place a propeller at each end of the frame, but the front one is to be so arranged that its axis can be turned to one side to guide the vessel. It contains 24,000 cubic feet, and has engines of 16 horse-power.

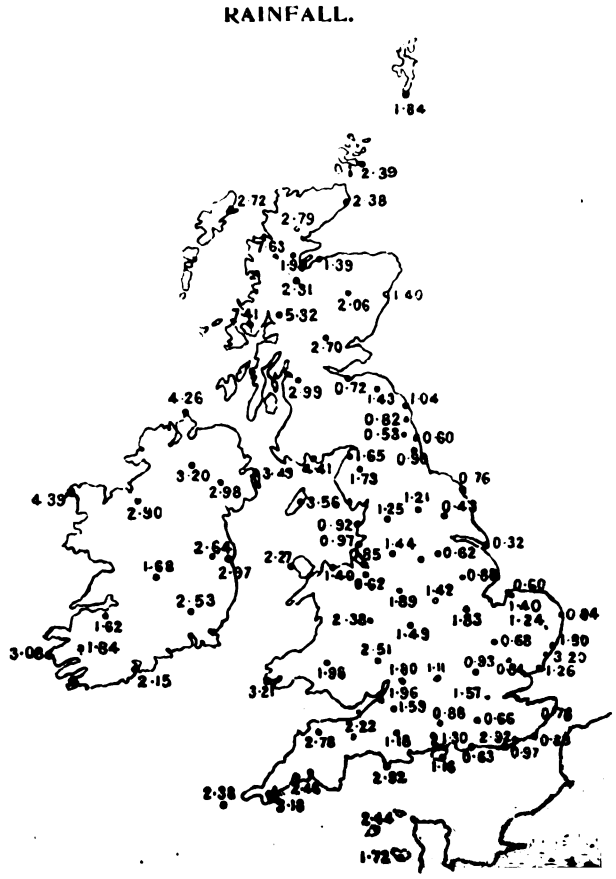
LAST YEAR'S WEATHER—SEPTEMBER, 1902.

DISTRIBUTION OF MEAN TEMPERATURE.



Over the greater part of England, and also on the north and east coasts of Scotland, the mean values were below the average, but in other districts they were as a rule above it, the departure in either direction being slight. Highest readings, over 70° in most places—77° in London. Lowest readings, 30° in Scotland.

RAINFALL.



Rainfall less than the average over the country generally, but, owing to a heavy fall on the 2nd and 3rd, it exceeded the normal in the north and east of Ireland, and also at some places in the west of Scotland. Over the eastern and central parts of Great Britain the deficit was as a rule very large.

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Researches in Tropical Diseases.

NOT only the scientific student, but the man in the street, is now cognisant of the importance and extent of current investigations into the various forms assumed by what are generally designated tropical diseases.

Among these, the types belonging to the malarial, beri-beri, tsetse fly, and sleeping sickness groups have sprung into prominence, and are enlisting the close attention of pathologists and laymen in divers parts of the world, but particularly in our West and Central African possessions and in India. Indeed, it is now recognised that maladies such as these induce are of infinite significance where colonisation is concerned, materially affecting the relationships and intercourse subsisting between European and native, and enforcing therefore the plain duty of investigation in the hope of the successful introduction of prophylactic measures.

Towards this desirable end the Liverpool School of Tropical Medicine has devoted time and money in unstinted degree, and not the least important among malaria expeditions was that to the Gambia, West Africa, conducted last year by Dr. J. Everett Dutton, under the auspices of this well-known institution. The prompt issue of a memoir, now available, detailing the operations of the expedition, and embodying the results and recommendations arrived at, deserves much praise.

In an undertaking of the kind in question, the scope of inquiry embraces, in the first place, topographical and statistical considerations, and the circumstances of social existence. Supplementary to these, and in part related, are those affecting water supply, drainage, climate, food, and, lastly, the prevalence of infection itself, and preventive methods.

The town of Bathurst, which formed the *locale* of the investigations, owns but a very small population of Europeans, their numbers being always under 100; on the contrary, there is a native population of some 15,000 persons. The former use rain-water for drinking purposes, which is gathered from the roof and stored mostly in large open tanks, while the natives derive their supply from wells. Both these sources furnish opportunities for contamination, especially when no more than the most ordinary sanitary precautions of a tropical settlement are observed or thought of. Now the connection between such storages and the breeding proclivities of certain species of mosquitoes, already demonstrated to be carriers of infection, is close, and one of the factors of the situation. The breeding sites range themselves under two heads, the natural and the artificial.

The former occur for the most part in the swampy districts, but a few natural hollows in some of the streets, more especially those bordering on the swamps, collect rain-water in which mosquitoes breed. According to the season of the year there ensues a considerable variation in the number of breeding haunts. Some interesting experiments were set on foot to determine the action of tidal water on the insects, and from these it would appear that certain kinds of mosquitoes can breed in tidal water if it is not disturbed. The abolition of the breeding places of the swampy localities is a work entailing much time and consists practically of raising the level of the swamps by the deposition of sand, together with a proper system of drainage. Among artificial breeding places may be mentioned the canoes, boats, and other craft on the foreshore. These gather rain-water and were found to be almost universally infested with larvæ. From a rough calculation that Dr. Dutton made it was estimated that each of the boats in question would produce 2,000 mosquitoes per week; and 50 boats of all kinds producing this quantity means a total of 100,000 mosquitoes per week distributed into the town. Then again, ample facilities exist for breeding on the premises of the traders, both white and native. In one factory yard were six barrels containing water, the latter more or less foul; in the garden were 17 tubs containing water for gardening purposes, and besides this number of utensils were eight small wells, uncovered. In all these receptacles mosquitoes were present, and the conclusion is reached that the wash-tubs, garden-tubs, wells, and rain-barrels occurring in "compounds" form the chief source of mosquitoes in Bathurst for at least six months of the dry season, when all other breeding-places, *artificial and natural*, have ceased to exist.

The blood of a large number of children in the Gambia were examined with the view of determining the presence of malarial parasites, and it was found that 80 per cent. of those under observation harboured parasites, from which it will be seen that the malaria index in Bathurst is high.

The practical measures that should be taken to ensure the destruction of mosquitoes is a subject of vast importance, as to which, however, differences of opinion exist, and similarly with regard to the adoption and enforcement of rules and regulations directed towards ameliorative sanitary conditions. It is apparent, however, that the two must go hand in hand, and unless civil authorities recognise and loyally interpret the investigations of medical experts, who are not faddists, but men who have set themselves the task of solving in our distant dominions a great Imperial health problem, the various schemes put forward will inevitably be strangled at the outset. To fight such ubiquitous insects as mosquitoes in their native haunts, to say nothing of those which are provided ready-made by the white man on his own premises, requires no mean effort, and, if only partial success has been attained so far, the more positive evils of the case may yet find repression. "Science moves but slowly, slowly, creeping on from point to point." That the European in the tropics through carelessness does frequently promote infection, however unwittingly, is easily seen from the foregoing recital of his environment in the Gambia.

Finally, it is matter for congratulation that no cessation of the tropical campaign is to take place on the part of the Liverpool School. A new expedition leaves this month by the *Albertville* for the Congo Free State, under the direction of Dr. Dutton, who will be accompanied by Dr. J. L. Todd and Dr. C. Christy. These observers are to report upon the sanitary conditions of various important centres, and make recommendations; they will also study the occurrence and distribution of trypanosoma in the Congo, the carriers of the parasite, and the relation of trypanosoma to sleeping sickness. The last-named may be regarded as work corollary to researches in that disease which have been carried on at Entebbe, Uganda, by Dr. Castellani, Colonel Bruce, and Dr. Nabarro, and which have already yielded remarkable results.

The Distribution of Life in Antarctic Lands.

THE following is an abstract of the Presidential Address delivered by Dr. Henry Woodward, LL.D., F.R.S., F.G.S., to the Norfolk and Norwich Naturalists' Society.

Glacial and Interglacial Periods.

During the past sixty years astronomers, physicists, meteorologists, or geologists have all laboured to elucidate the causes and extent of the glacial period or periods.

It seems certain that such epochs have been in great measure brought about by a combination of astronomical causes such as the inclination of the earth's axis and the ellipticity of her orbit. But to whatever combination of causes such climatic alterations may be due, "It is," as Sir Robert Ball has said, "essential to the astronomical theory of the Ice Age that such interglacial and glacial periods must have alternated with one another at the opposite poles of our earth."

The facts of the occurrence of extensive beds of coal and lignite, associated with shale beds, rich in leaves of dicotyledonous trees, and shrubs in Arctic America, in North Greenland, &c., within the Arctic Circle; and beds of coal with abundant tree trunks in the Antarctic *where no trees now exist*, testify to great changes of temperature in circumpolar regions, such as would, if they recurred, render these lands again habitable to plants and animals in warmer temperatures.

There is a fundamental difference between Arctic and Antarctic conditions. In the Northern Hemisphere a polar sea is almost completely surrounded by continental land, and continental conditions for the most part prevail. In the Southern Hemisphere there is almost certainly a continent at the south pole, completely surrounded by the ocean, and oceanic conditions prevail.

The Antarctic Continent.

South of latitude 45° S. we meet with low atmospheric pressure all the year, with strong westerly and north-westerly winds, and large rain and snowfall all round the South Polar regions. But there are many indications that the extreme South Polar area is occupied by a vast anticyclone out of which winds blow toward the girdle of low pressure outside the ice-bound region.

ANTARCTIC ICE.—The most striking feature of the Antarctic is the huge table-shaped icebergs, having a thickness of 1,200 to 1,500 feet, marked by regular stratification, and presenting lofty perpendicular cliffs which rise 150 to 200 feet above and sink 1,100 or 1,400 feet below the level of the sea. Ross sailed for 300 miles along what was evidently the sea front of a great creeping glacier of the kind which give rise to these table-shaped icebergs, whose ice has been formed on an extended land surface, and pushed out over low-lying coasts into the sea.

But all the Antarctic land is not surrounded by inaccessible cliffs of ice. Along the seaward face of Victoria Land, the ice and snow which descend to the sea apparently form cliffs not higher than from 10 to 20 feet, and, in 1895, Kristensen and Borchgrevink landed at Cape Adare, on a pebbly beach occupied by a penguin rookery without encountering any ice descending to the sea. Apart from the shape and structure of Antarctic icebergs, another indication that they have flowed over an extensive land surface is to be found in the quantities of rock fragments, sandstones, limestones, &c., which have been distributed by them over the ocean floor, and dredged up by the *Challenger*. It is not expected that a living land fauna will now be discovered beyond the penguin rookeries, but fossil remains discovered in these regions indicate a much warmer climate in times past, and will throw important light upon the cycle Antarctic land.

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Kerguelen Islands, Lat. 49° 20′ S. Long. 69° 24′ E., Sir James records in his visits to the Island of Kerguelen in 1840, the occurrence of a bed of coal, four feet thick and 40 feet in length (exposed) near Arched Point, Christmas Harbour, 30 feet above the sea, and covered by basalt. Silicified trunks of trees are also met with, some of which brought home by Sir Joseph Hooker, are preserved in the British Museum.

Ross mentions another bed of coal in Cumberland Bays, 1 foot in thickness, covered by porphyritic amygdaloidal, a greenstone rock.

When Captain Cook visited Kerguelen in the height of summer the land was covered with snow (1768) and only five plants in flower were collected. The observations were made by Surgeon Robert McCormick and Assistant-Surgeon Joseph D. Hooker by the *Erebus* (1839—43). Hooker records 150 living plants, 18 of them flowering plants.

Mr. R. McCormick, who accompanied Ross, wrote: "Since the successive overflowings of volcanic matter destroyed the forests, which at one time clothed this land, by which the fossil trees and numerous beds of coal afford abundant proofs, it has remained in a state of almost vegetable desolation ever since."

Ritter suggests that the volcanic chain forming the eastern face of Victoria Land is the continuation of the New Zealand volcanic line, and that the coast of Wilkes' Land is a southern extension of the Australian plateau. Dredging supports this view.

Indirect evidence favours a land connection with a chain of peaks stretching from Victoria Land and the vicinity of Mounts Erebus and Terror to Graham's Land.

If this great line can be proved, the volcanic chain encircling the Pacific Ocean will be rendered complete, joining up the Antarctic Land with New Zealand and Australia on the one hand and Graham's Land to South America on the other.

Bipolarity and Bipolar Faunas.

There is an interesting question, too, in reference to the littoral and shallow water fauna and flora of the Antarctic lands as compared with the Arctic.

Of the seals and walruses, the northern sea lion, the largest of the genus, 10 feet long, is represented by the southern sea lion and some other corresponding species. The walrus *is only found in the Arctic seas.*

The true seal is common to the North Atlantic and Pacific coasts, but does not occur in the southern ocean.

The penguins may be said to represent in the southern ocean the auks and divers of the northern seas.

Whether these are all (as are the penguins and auks) merely representative forms, or whether they may have in some cases been able to cross the equatorial region, and reach the Arctic from the Antarctic, is an open question. It must be remembered that cold polar currents do reach near the Equator on the South American-Chilian coast.

Fifty years ago there were very few men of science bold enough either to suggest or to accept the theory that the Geographical Distribution of Plants or Animals had actually begun far back in past geological times.

Australia was deemed to be a survival from the Jurassic period, New Zealand from the Triassic, and so on. Australia is now known to possess representatives of almost every formation from Cambrian and Silurian times to the Tertiary.

In Favour of a Southern Connection of Antarctic Lands.

A. R. WALLACE, in "Island Life," says: "Wherever we find a considerable number of the mammals (or flightless birds) of two countries that exhibit distinct marks of relationship we may be sure that an actual land connection has at one time existed."

CHARLES DARWIN says in "The Origin of the Species," that "New Zealand, South America, and the other Southern lands have been stocked in part from the Antarctic Islands, where they were clothed with vegetation during a warmer Tertiary period."

Dr. W. T. BLANDFORD, F.R.S., believes that "There is no improbability in the suggestion that at some period of geological history, an important Continent having connections with South America, South Africa, and New Zealand may have occupied the Antarctic Seas."

It is probable that a very large extent of ancient land around the present Antarctic Continent has been lost by submergence, and that the small islands in the surrounding ocean indicate the land which has disappeared. Their volcanic activity supports this view.

Peculiarities of Southern Land Faunas.

In no other part of the world do we find such a remarkable assemblage of struthious birds, both of living and extinct forms, as are distributed over the continents and islands which encircle the Antarctic.

Australia possesses a peculiar fauna belonging to the Monotumata and Marsupialia. The former represent the sole surviving forms of the lowest division of the mammalia, viz., the Prototheria, of the order Montumata (egg-laying mammals), which are confined to Australasia.

The most remarkable discovery of late years bearing upon the wide distribution of similar animals over the Southern Continents is that of Miloania, an extinct genus of land tortoise. The first example of Miolania was found in Queensland, Australia; the second in Lord Howe Island, 300 miles to the eastward of the Great Barrier Reefs. The third was lately obtained by Dr. Moreno in Argentina, South America, yet they can only be differentiated specifically, notwithstanding their enormously wide geographical separation from one another.

A summary of the flora characteristic of the Southern Hemisphere fully confirms the conclusions derived from a study of the fauna, and establishes beyond a doubt the former existence of extensive land connections between the Southern Continents and Islands in Tertiary times which have since disappeared beneath the ocean.

Plantae Southern Hemisphere.

Of the "SAXIFRAGES," only two out of the thirty-five genera cross the Equator into the Northern Hemisphere.

Of the Protaceæ, the Banksias have 49 genera, only 25 of which cross the Equator. Some occur, fossil, in Miocene and Cretacious Plant-beds in Europe.

Fuschia and Parsiflora are common to New Zealand and South America. New Zealand and South America have 74 genera in common, 11 identical and 32 closely-allied species.

That earth-movements, on a widely-extended scale, have occurred in the South is evidenced by the very late elevations and subsidences which have taken place in parts of the Andean Chain and in Tierra-del-Fuego, also in Kerguelen Island, Eastern Australia, Tasmania, New Zealand, and the Chatham Islands; while the vast upheaval of the Himalayan range itself is only of the newer Tertiary ages.

REVIEWS OF BOOKS.

Astronomy for Everybody, by Professor Simon Newcomb (Isbister), 7s. 6d., is, as its title implies, a plain unvarnished description of the heavens, simply worded, giving a concise account of each object of interest, and not tarrying too long on any one to render it tedi us. Astronomy is a fascinating subject, and many fascinating books have been written about it, but the present volume stands well in with them all. Every sentence is of interest, and while not pretending to be an exhaustive treatise, it has the merit of being the announcement of one of the greatest authorities on the subject. The author is the superintendent of the United States Nautical Almanac, and has a world-wide reputation as an astronomer and as a writer. The book commences with a very eulogistic preface by Sir Robert Ball, after which Professor Newcomb launches forth on the generalisms of the Celestial motions and the constituent components of the heavens. He then gives a lucid description of the principles and of the working of the telescope and other astronomical instruments. We are then given a glance of the Solar system and a description of each of its principle elements, as well as comets, meteoric bodies, and finally a review of the fixed stars. Thou.h not a large book, numbering a little over 300 pages, it may safely be said that anyone having read it carefully through may consider himself well grounded in the Astronomy of to-day.

Reprints from the University of Chicago Decennial Publications (University of Chicago Press):

The Early Development of Lepidosteous Osseus, by Albert Chauncey Eycleshymer. This is an account of the early phases of development as observed in living and in preserved material, followed by a comparison of these phases with those of other ganoid fishes; concluding with general remarks on the character and significance of cleavage.

Mitosis in Pellia, by Charles Joseph Chamberlain. This investigation deals with the first two nuclear divisions in the germinating spore. For comparison, however, mitosis was studied in other phases of the life history. The principal conclusions are as follows: The stimulus to nuclear division comes from within the nucleus. The asters are of cytoplasmic origin. The caps come from the outer portion of the nuclear membrane or from a *Hautschicht* surrounding the nucleus. The appearance and disappearance of the astral rays suggest that they are concerned in the movement of nuclear matter. The centrosphere is formed by the astral rays, not the rays by the centrosphere. The centrosphere, or Pellia, represents a condition intermediate between the well-defined centrosphere of some of the thallophytes and the centrosomeless condition of the higher plants. The spindle fibres, except the mantle fibres, grow from one pole to the other. In early stages two half-spindles are often distinguishable.

Ternary Orthogonal Groups in a General Field, and the Groups Defined for a General Field by the Rotation Group, by Leonard Eugene Dickson. The first paper is on investigation for an arbitrary field (realm of rationality) of a subject previously treated for a continuous field by Weber, and for a Galois field by the writer; and the second is a contribution to the theory of group-determinants and group characters due to Frobenius and Burnside for continuous fields, and to the writer for arbitrary fields.

The Origin of Angiosperms, by John Merle Coulter. The statement of a theory based upon investigations during several years by various members of the department. The common or independent origin of Monocotyledons and Dicotyledons is discussed, the conclusion being reached that they are independent lines. In case the Angiosperms prove to have a common origin, evidence is advanced to show that the Monocotyledons represent a specialized offshot from the Dicotyledons, contrary to the recent general impression that the Monocotyledons are the more primitive. The origin of Angiosperms from Gymnosperms is shown to be untenable, and even such heterosporus Pteridophytes as *Isoetes* and *Selaginella* are very improbable ancestral forms. The general conclusion is reached that the Angiosperms have been directly derived from the eusporangiate ferns, the transition forms to the Monocotyledons being unknown, but the transition forms to Dicotyledons being represented by the abundant and problematical "Proangiosperms" of the early Cretaceous.

The Distribution of Blood-vessels in the Labyrinth of the Ear of Sus Scrofa Domesticus, by George E. Shambaugh. The circulation of the labyrinth is worked out for the ear of the pig by using Eichler's method of making celloidin casts of the labyrinth. A large series of embryos was injected, of sizes measuring from 2½ cm. in length to the embryo at full term, measuring about 30 cm. The simpler scheme for the distribution of vessels found in the younger embryos was utilized in interpretating the complicated system of vessels found in the labyrinth at full term. Ten drawings in colours illustrate the articles.

Studies in Fat Necrosis, by H. Gideon Wells. A series of experimental studies on the pathogenesis of inter-abdominal fat necrosis, of the type following pancreatic lesions, based upon the observation that the typical process can be produced experimentally with dried extracts of the pancreas. This has given opportunity for control of conditions which cannot be attained by the methods previously used, making it possible to approach the question of the causative factor in an exact manner. The study of the thermal death-point of the necrosis-producing element of the pancreatic extract shows it to be in all probability a ferment. The order of development of the changes in the lesions indicates that the necrosis is primary and the fat-splitting secondary.

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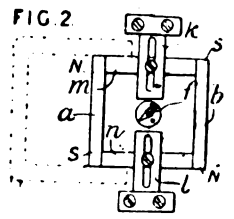
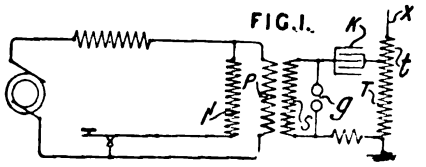
Recent Patents.

6434. Magnetic measurements. BRANDER, B., 7, Hillaries Road, Gravelly Hill, Birmingham. March 15.

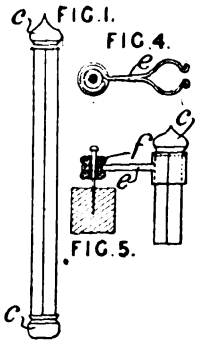


The magnetic power of any steel magnet is tested by opposing it to a standard magnet, with or without the use of pole-pieces, and observing the direction of the resultant magnetic field, this indicating whether the magnet tested is stronger or weaker than the standard. The direction of field may be observed by a pivoted magnetic needle *f*, moveable between stops, and this may be placed between stationary soft-iron pole-pieces *k*, *l*, carrying adjustable yokes *m*, *n*, to which are applied the magnets, *a*, *b* to be compared. Horse-shoe magnets may be applied outside the yokes *m*, *n*, as shown in dotted lines. The magnets may be compared with two or more different standards. The standard may be a steel magnet, or an electromagnet supplied with a measured current through a rheostat. In comparing magnets for telephone-call generators they may be applied outside two straight stationary pole-pieces.

6481. Wireless telegraphy. SHOEMAKER, H., 827, Arch Street, Philadelphia, Pennsylvania, U.S.A. March 17.



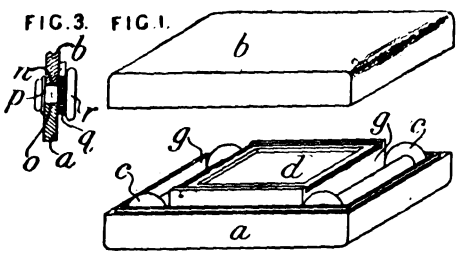
Relates to transmitters for wireless telegraphy. The transmitting-key is arranged to cut in or out an inductance T across the closed circuit of the primary *P*, the secondary *S* being arranged with a spark-gap bridge *g* and being connected to the aërial conductor *X* by means of an adjustable two-part inductance *T*, *t* as shown. In modified arrangements, a subsidiary inductance may be bridged in with the primary and then the primary circuit broken, the inductance circuit being closed. The transformer may also have an extra low resistance coil in circuit with a transmitting-key and smaller inductance. The aërial conductor may also be arranged in the secondary of a transformer in the spark-gap circuit.



6726. Electric lamps. WOHLMUTH, T., 5, Naglergasse, Vienna. March 19.

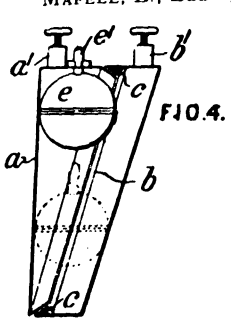
Incandescent lamps are made of tubular forms, either straight or curved, with filaments extending through them between end caps *c*, Fig. 1. They may have the form of letters, or may be put together to form letters or designs, for signs or decorative or other purposes. They may be held in spring clips *e*, which are carried by porcelain insulators *f* on nails or screws.

6887. Photography. BARTLETT, E. D., 2, Nithdale Road, Plumstead, Kent. and HOUGHTON, G., 88, High Holborn, W. C. March 21.



Cameras; roller slides.—Relates to a camera combined with a roller slide. The back of the camera is formed like a box *a*, Fig. 1, with a lid *b*. In the centre of the box is formed a recess *d*, into which the bellows of the camera is packed when not in use. The film spools *c*, *c* are mounted in chambers *g*, *g* at the ends of the recess *d*, and to facilitate insertion and removal the bearings are placed at the junction of the parts *a*, *b* and are made in halves *n*, *o*, Fig. 3, stepped together, as shown by the dotted line. The turn-key *r* has a collar *p* inside and a ratchet wheel *q* outside to prevent the reversal of the spool. In the Provisional Specification, a modification is described, in which the spools are mounted on the ends of radial arms; methods of attaching the discs to the film roller and of connecting the winding key are also described.

9720. Fire-alarms. OFFENBROICH, P., 26, Leipzigerstrasse, Berlin, and MAFELL, L., Ludwigshafen-on-Rhine, both in Germany. April 26.



Relates to a device for automatically closing an electric alarm circuit in case of fire. As shown in section, Fig. 4, this device consists of a wedge-shaped box made in two halves *a*, *b*, which are insulated from each other by the fillet *c* and are furnished with terminals a^1, b^1, to be connected to the electric circuit. A ball *e* of conducting material is suspended from the top of the box by a pin of fusible material passed through the tang e^1. When the pin is fused by the heat of the fire, the ball falls down into the position shown in dotted lines, thus closing the electric circuit by making contact with *a* and *b*.

ANSWERS TO CORRESPONDENCE.

PRESERVATION OF FLOWERS.—C. S. P. asks, with reference to an article in our issue of October last on the preservation of flowers by covering them in sand, (1) What is the cause of specimens so treated coming out "floury" in appearance and limp? The limpness is evidently due to the flowers not being sufficiently dry. Either they have not been left long enough in the sand, or else the latter was not perfectly dry. It is better that the sand should be baked quite hot first. (2) What is the best method of removing the sand so as not to disturb the flowers? Perhaps the best way is to have several holes in the bottom of the box stopped by pegs until it is desired to remove the sand, when they can be withdrawn and the sand allowed to flow out gradually. The position of the flowers is immaterial.

Prize Competition

ONE of the principal objects of this journal being to encourage and foster the introduction and propagation of new ideas, the Proprietor offers a series of money prizes to those who, in his opinion, send in the best and most practical solutions to certain problems, which will be set each month.

The competitor gaining the greatest amount of marks each month will be awarded the monthly prize of ONE GUINEA. But in order to encourage clever inventors, and not merely reward those who may happen to hit upon a happy idea, a GRAND PRIZE OF **ONE HUNDRED POUNDS** will be awarded—after twelve problems have been sent—to that inventor who shall have gained the greatest aggregate of marks during that period, provided he shall have gained at least *30 per cent. of the full marks* in at least six of the competitions (whether he has gained a monthly prize or not).

RULES.

1. Designs to be sent in to the office before the end of the current month, accompanied by the coupon cut from this paper.
2. The solutions sent in must be concise, yet fully descriptive of the idea intended. To comply with this they must not exceed 300 words, and not more than two simple diagrams should accompany it.
3. Solutions will be published as considered desirable by the editor.
4. Competitors may obtain patent rights for their ideas, but they must run all risk of the publication in this paper interfering with the obtaining of such rights.
5. Competitors may send in their designs under a fancy name for publication, but their true names and addresses must be inserted on the coupon, which, in the event of their winning a prize, will be published. The same fancy name must be adhered to throughout in future.
6. The same person may send in two solutions so long as a separate coupon accompanies each. All marks so gained will count for the grand prize, but the monthly prize will only be awarded for the one best solution. If the two solutions appear to the judge to be but slight variations of the same invention, marks will be deducted from the second solution.
7. Novelty of design is not a *sina qua non* (since this would be extremely difficult to prove), but only the person sending a description with the coupon is entitled to reward.
8. It would add to the value if a statement be added to say if the design has been practically tried; but to corroborate this the inventor may be called upon to give a demonstration before receiving a prize.
9. In the event of an equality of marks or any other exceptional circumstances, the proprietor will decide on the fairest method of distributing the prize.
10. Non-compliance with the above rules may disqualify a competitor.

The gentleman (a professor of mathematics in one of the Universities) who is acting as judge for last month's competition, being abroad for his holiday, has not yet sent us his decisions, so we regret that they cannot be announced till next month.

"MEPHISTO" writes to point out that an evident misunderstanding occurred with regard to his solution of the problem, "Marine Engine." On reading it through again we understand his meaning, although the description is certainly very vague. As the system now explained is undoubtedly included in the answer, we award him 20 marks more.

The Subject for next Month will be—

BURGLAR ALARM,

or method of intimating the presence of persons by electric or other means, with provision against its giving false alarms.

COUPON.

To the Proprietor, ILLUSTRATED SCIENTIFIC NEWS.

I herewith forward my idea for a solution of the problem on "Burglar Alarm," according to the conditions published in your paper, and I agree to comply with those conditions.

Full Name.....

Address.....

.....

Fancy Name for publication.....

Date.....

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THE ILLUSTRATED

Scientific News.

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Communications should be addressed to the EDITOR,
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Advertisements, address THE MANAGER.

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The British Association, 1903

Notes and Abstracts of Papers.

THIS year's meeting of the British Association at Southport will be remembered as the Educational Meeting. Sir Norman Lockyer's Presidential Address stated the case for the scientific development of the education of the country with a clearness, certainty, and force which place it definitely among the great addresses delivered before the Association. His appeal was, in part, an amplification of the warning against the neglect of national scientific training, which was uttered by Professor Dewar last year. In this aspect Sir Norman Lockyer followed not Professor Dewar alone, but many Presidents of the Association who have, since Sir David Brewster's day, repeatedly deplored the "natural discouragement given to men of science," and have urged the necessity of national scientific reform if national industry was to be maintained. But Sir Norman Lockyer's address differed from that of his predecessors in two respects. He laid his finger on the spot which is the national weakness; and he stated a definite remedy. The national weakness is not in the delay of manufacturers to adopt scientific improvements. British manufacturers adopted scientific improvements in mid-Victorian times; they were the first to do so; and more than one powerful British industry owed its origin to the ready shrewdness of the British manufacturers in taking advantage of scientific inventions and scientific improvements in industrial processes. But while doing this the nation as a whole was always slow to apply the scientific method to the cultivation of brain power; to education; to mental improvement. It resembled a workman who can use a voltmeter, or a man who can send a telegram; but who is quite uninformed as to the processes of electricity. It reaped the advantages of science at a time when Germany was not consolidated, when Italy was under the Papacy, when France had yet the war of 1870 to fight; and when the strife between North and South impended over America. But it always remained uneducated. When the other nations, their political troubles over, began to enter the race as unhandicapped competitors, they too began to use scientific inventions. But after 1870 they began to cultivate not the use of inventions alone, but the mind of their growing peoples. The consequences were that first our advantage in the handicap began to lessen. When the other nations caught us up, they were armed not only with the same scientific inventions as ourselves, but—by reason of the attention they had given to the cultivation of national brain power—with minds and men better able to make use of and to improve on these inventions.

Not only did Sir Norman Lockyer thus correctly diagnose the reasons for our industrial decline, but he showed the remedy for it; and this remedy is the national subsidising of new and scientific Universities. We must pay more for the cultivation of our national brain power. Sir Norman Lockyer suggested £24,000,000, which is about one-tenth the cost of the South African War, as the amount necessary to put our higher education on a proper basis. The President's plea was supported strongly from various sides, and from various aspects, by most of the Presidents of Sections; and it also received the support of Sir Robert Giffen, who showed how absurdly small the amount the country spent on education was in comparison with its Food and Drink Bill. In the Mathematical and Physical Science Section, Professor C. Vernon Boys urged that education should go hand in hand with the scientific needs of industry, and laid especial stress on the more practical teaching of mathematics and the elements of physics in schools. In the Geological Section, Professor W. Watts pointed out the educational importance of geology; and similar pleas were put forward in the sections of Botany, Zoology, and Educational Science. We do not propose in this number of the "ILLUSTRATED SCIENTIFIC NEWS" to summarise the addresses, or, beyond the indication of their general scope, to give abstracts of their contents; because we think that Presidential and Sectional Addresses are intended to be read as a whole, and not as extracts. We therefore propose to give only notes and abstracts of a few of the less technical papers and reports which were read before the sections.

Road Waves.

Among the reports presented to the Association were those of the Committee on the form of terrestrial surface waves. A photograph was exhibited of a curious wave effect which is produced on roads or on tracks of any loose cohesive material over which sledges travel.

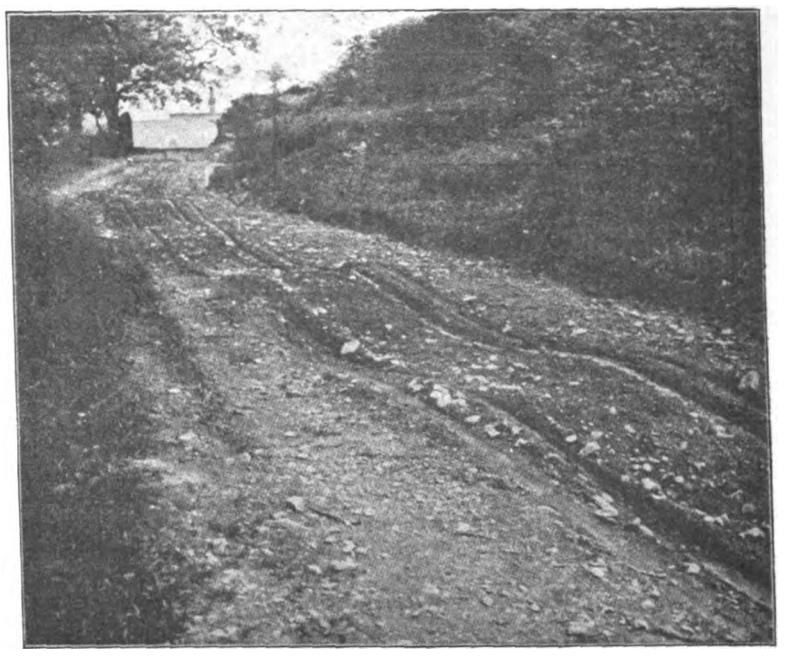

Plate I.

An investigation on this subject was completed after last year's report had been sent in, but was made the subject of a paper to Section G (Belfast meeting). These undulations have been observed both in snow and in ordinary road material. Those in snow are a familiar feature in Canada, and are termed cahots. An illustration is here given of "cahots" in ordinary road material as observed upon the road to a slate quarry at Coniston, Lancs. (Plate I.). The chief result of the investigation may be summarised thus: When the detritus consolidates readily under pressure, undulations arise spontaneously by the action of a steadily-moving sledge when furrowing a homogeneous road. The wedge of detritus travelling in front of the prow of the sledge becomes compacted, the sledge surmounts it (rolling like a wheel), and the detritus remains behind as an excrescence incorporated with the road. At the same time the sledge pitches, furrowing the road more deeply and accumulating detritus in front, which it finally surmounts with the rolling movement which assists to compress and bind the material, building up the next crest.

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Birds that Pass in the Night.

This year witnesses the last report of the Commitee appointed by the British Association to inquire into the Migration of Birds in Great Britain and Ireland; and, besides several most important general conclusions, special information is given with regard to starlings and rooks. Of the eight species which have been the chief subject of attention of the Committee appointed to work out the details of the observations on the migrations of birds at lighthouses and lightships, 1880—1887, only two or three at most—the swallow, the field-fare, and, perhaps, the white wagtail—are popularly considered to be "migrants" in this country, the others being species resident in it throughout the year. Yet nothing has been more clearly proved than that, as individuals, song-thrushes, skylarks, lapwings, starlings, and rooks are migratory in the highest degree; a fact which had before been known to comparatively few ornithologists, and wholly unsuspected by the public at large, though these are among our most familiar birds. The Committee state it as their opinion in this, their final report, that no great advance of our present knowledge of the subject is likely to be made without the application of new methods of inquiry. One important fact has been established beyond all doubt, that bird migration is carried on for the most part at night, though at present no explanation is forthcoming as to the means by which the birds are able to direct their course on their nocturnal journeys. Mr. William Eagle Clark submitted histories of the various migrations performed by the starling and the rook, species whose movements present special points of interest, while those of the former are of a more complex nature than are found in any British bird.

Starlings.

The starling is a summer visitor to Northern and much of Central Europe, and a winter visitor to Southern Europe and Northern Africa. In the British Isles it is a resident, a partial migrant, a winter visitor, and a bird of passage. The migrations of the starling observed in Great Britain and Ireland are of a singularly varied nature, being performed with great frequency and at all seasons. These remarkable characteristics of a well-known and familiar bird are due to a number of causes—among others to its gregarious and desultory nature, the varying degree of its migratory instincts in different parts of the British area, its dependence upon supplies of food, which not only change with the season but from year to year, and to the fact that it is double-hooded; peculiarities which result in innumerable movements, many of them of a partial or wholly irregular nature. As a resident species, the starling is widely distributed over our islands, its range extending from the Shetland and other northern isles southward to the English Channel. In many of the northern and in the more elevated portions of the mainland of Britain the bird is migratory, being entirely or partially absent during the winter months.

Summer and Autumn Movements

take the form of local migrations, and of the emigrations of native birds to winter abroad. The local migrations begin in the early summer, so soon as the first brood are able to shift for themselves. About the middle of June flocks of young birds begin their wanderings. Later in the summer both old and young gather together, and movements take place, at first in search of fresh feeding grounds, and finally to winter homes. These movements later in autumn merge into those of the Continental hosts seeking winter retreats on these islands. Besides these local movements, the summer and autumn emigrations take place. A number of British-breeding starlings depart from the south coast of England and cross the Channel towards France from late in July to the middle of September. During the last week in September up to November, autumn immigrations take place, probably from Western Central Europe, the starlings appearing on the English coast from the Humber southwards to the Channel. Many of these immigrant starlings winter in England and Ireland, others pass along our south-western shores to South-Western Europe. The autumn immigration on our shores of birds from Scandinavia begins rather later than that from Central Europe. Vast numbers of the starlings which arrive on our shores in the autumn do not remain for the winter, but proceed on passage to retreats in Western Europe. During exceptionally severe winter weather many of the would-be winter residents (chiefly our Continental guests) fly to the coasts or leave for the Continent. As early as February the starlings begin to return to their summer quarters from abroad, and about the same time the starlings which have wintered in England take their departure from us.

Rooks.

In the same way extensive migrations take place among rooks. Partial movements on the part of young and old begin at the close of the nesting season. The principal autumnal movement is that which takes place from September to November, when vast numbers of rooks from Central Europe arrive on the south-east coast of England to winter in the Eastern Counties. Late in February, up till April, numbers of rooks arrive on the south-east coast of England from the Continent, moving in a westerly-north-westerly direction. These are most probably returning British emigrants, whose departure in the autumn escaped notice. Early in February and until mid-April the rooks from Central Europe, which have wintered in England, depart from the south-east coast for their summer homes. This is the most important movement of the spring.

Earthquakes and Earth Tremors.

THROUGH Mr. John Milne, who may be regarded as in many respects the founder of modern seismology, the Seismological Committee again published a map of the region of origin of the great earthquakes whose tremors are felt over the world. The means of ascertaining the origin and extent of these tremors, which are registered at observatories ranging from Shide to Wellington and Christchurch in New Zealand, from Edinburgh to Toronto, from San Fernando to British Columbia, from Calcutta to Trinidad, from Batavia to Argentina, from Honolulu to Irkutsk, from the Cape to Cairo, and at a hundred other places—have been explained by Mr. Milne on many occasions; and a plan of the regions of great earthquakes has been previously published in the "ILLUSTRATED SCIENTIFIC NEWS" (Dec., 1902, pp. 38 and 39—"The Observer of Earthquakes"). We need only remark in additional explanation of the map, which for the most part explains itself, that the regions enclosed in dotted lines are those at which great earthquakes originated. Generally speaking, as in the cases of the great areas running from north to south of America, and those lying off the coast of Japan or encompassing Borneo and Northern Australasia, these regions are found where great mountain ranges run down steeply into the sea, often to great depths. Mr. Milne's accepted explanation is that the earthquakes in these regions are frequently, if not generally, produced by the slipping of strata owing to the enormous superincumbent weight. This year's report proceeds:—

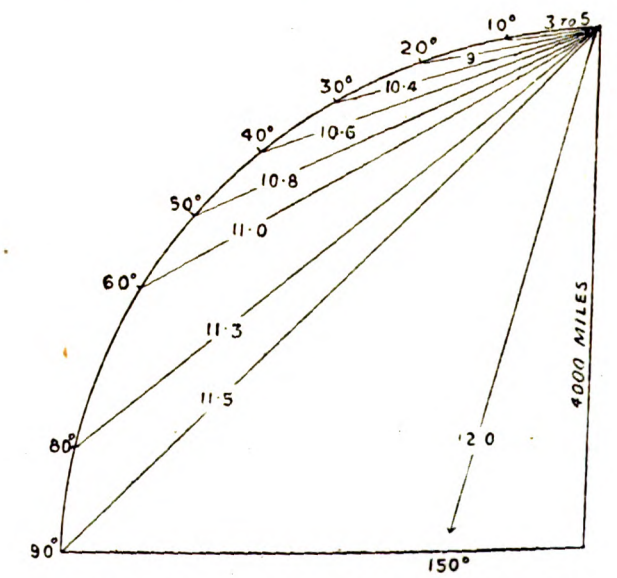
The Origin of Large Earthquakes Recorded in 1902 and since 1899.

On the accompanying map (fig. 1) the origins for 1902 are indicated by small numerals which correspond to earthquake numbers in the Shide registers. These are divided into districts marked alphabetically. The large numerals give the number of large earthquakes which have originated in each district since 1899. The chief feature in the map for 1902, as compared with those for preceding years, is the increase of activity shown for the Caucasian-Himalayan district K and the decrease in the Alaskan and Andean regions (A and D). If we omit districts E and A, then, as pointed out by Professor Libbey, a circle of about 70° radius and centre 180° E. or W. longitude and 60° N. latitude in Behring Straits passes through the seismic regions of the world which are at the present time most active. On the map this is indicated by a dotted line. The Pacific origins fall on a circle about 75° in radius, with its centre 180° E. or W. longitude and 30° S. latitude.

Mr. J. H. Jeans, in his paper on "The Vibrations and Stability of a Gravitating Planet," suggests that these regions lie on a great circle of which England is the pole, this circle being the equator of the supposed pear-shaped form of the world. The equator for the pear-shaped form, according to Professor W. J. Sollas, has its centre about 6° N. latitude and 30° E. longitude.

The Core of the World.

Another paragraph in Mr. Milne's report records the speculations which are based on the observed speed of earthquake tremors along arcs of the earth's surface. From these speeds the velocities of the tremor through portions of the earth's interior can be deduced. The



Arcs and Chords of the Direction of Earthquake Tremors.

velocities are calculated on the assumption that the paths of earth tremors have been arcs or have approximated to chords. From this are obtained velocities equal to 10½ to 12 kilometres a second for earth tremors. Mr. Milne's report proceeds:—

"The high values of 10·5 to 12 km. per second suggest a high rigidity for the world, whilst the approximate uniformity of speed within its core indicates approximate uniformity in those properties

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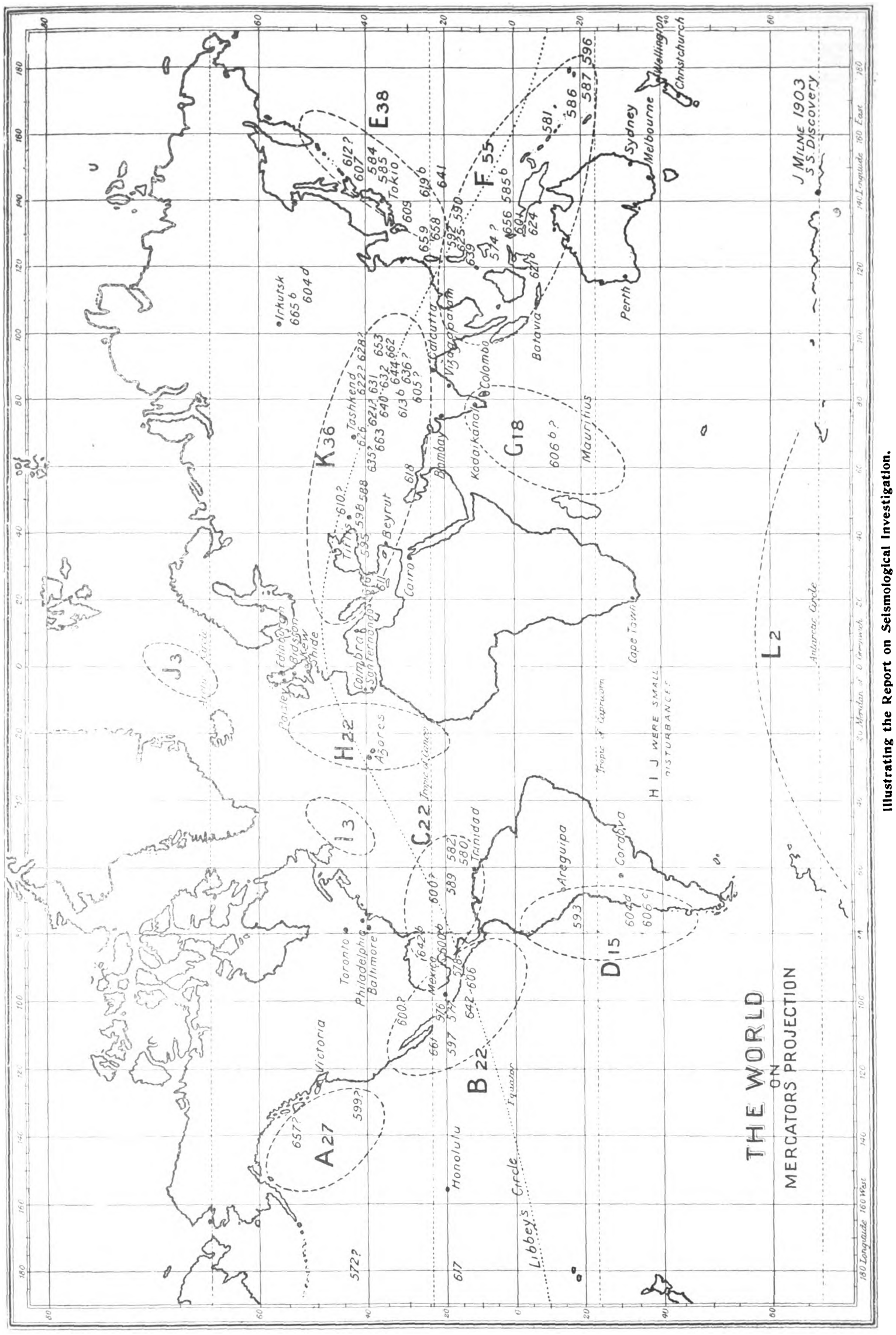
THE LARGE EARTHQUAKES OF 1902.

Origins for 1902 are indicated by their B.A. Shide Register number. Earthquake districts are indicated A, B, C, &c., and the number of earthquakes which since 1899 have originated from these is expressed in large numerals. Observing stations are named.



Illustrating the Report on Seismological Investigation.

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which determine the rate at which it transmits vibrations. Unless it is assumed that as we descend in the earth electricity and density increase in the same ratio, to which hypothesis there are objections, the inference is that the nucleus of the world has a density more nearly uniform than is generally assumed.

"To satisfy the interpretation given to these seismometrical observations, what is required is a globe with an approximately uniform nucleus not less than $\frac{19}{20}$ of the earth's radius covered by a shell which passes rapidly upwards into the materials which constitute the crust of the world.

"That low velocities are found on wave paths corresponding to chords of less than 10° suggests that this crust is not more than forty miles in thickness. This seismometrical determination of thickness for the earth's crust accords, it will be observed, with determinations of the same quantity which are chiefly dependent upon the effects of high temperatures assumed to prevail at such a depth. At fusion temperatures liquefaction is a state for many substances which is promoted by pressure, whilst at still higher temperatures Arrhenius points out that, whatever the pressure might be, it seems probable that fluids would become gaseous, and such gases would be dense, but slightly compressible and viscous. What the velocity table (as it now stands) indicates is that a crust passes rapidly into a nucleus which is exceedingly rigid and fairly homogeneous. A specific gravity can be defined for this nucleus which will meet the requirements of gravitational observations, and it seems likely that the same may accord with the tests of the astronomer."

Earthquake Great Circles.

[To the report of the Seismological Committee we append the following article which has been specially translated for the *Illustrated Scientific News* from Cosmos.]

Long ago the circumference of the Pacific was styled the "Ring of Fire" on account of the numerous volcanoes by which it is girdled, and, again, because the frequency of earthquakes was noted in the vicinity of the Mediterranean depression, ideally prolonged to the Antilles and the Indo-Gangetic plain. The records of major earthquakes during recent years help to substantiate this belief. The number of earthquakes recorded by the observatories of the world is 156,878. It is to be understood that the purely instrumental shocks or microseisms are eliminated, their epicenters being too often unknown. Only macroseisms have been noted. If we consider the great circle of the terrestrial sphere, the pole of which is the point 35° 40′ N. and 20° 40′ E. (Paris), which we shall call "Ando-Japanese-Malay" or "Pacific," we see that a zone of about 15° on either side contains the epicenters of 64,426 tremors or earthquakes distributed as follows in seismic regions really very unequally unstable.

Second Western Quadrant—North: North Andes, Antilles (Porto-Rico to Granada), Panama and Darien, 3,494 tremors.

South: South Andes, Central Andes, Guayaquil, 6,368 tremors.

First Western Quadrant—North: Atlantic versant of Costa-Rica, Greater Antilles, Honduras and Belize, British Columbia, Alaska, 897 tremors.

South: Pacific versant of Costa Rica, Nicaragua, Salvador, Guatemala, Mexico, California and Rocky Mountains, Aleutian Islands, 13,018 tremors.

First Eastern Quadrant—North: Kamchatka and coasts of sea of Okhotsk, Mongolia, Manchuria, Saghalien, W. of Isle of Yezo, Leao-Tung and Corea, Coasts of China, Isle of Hainan, Malacca, N. of Sumatra (N. of the Benkülen-Singapore line), 2,482 tremors.

South: Kurile Islands, rest of Japan, Formosa, Liuk-iu, Philippines, Mindanao, Borneo, Moluccas, S. of Sumatra, Java, 38,167 tremors.

The other great circle Alpine-Caucasian-Himalayan-New Zealand or Mediterranean, has for pole the point 40° 45′ N. and 152° 30′ W. of Paris. Its corresponding zone of same extent contains the epicenters of 84,023 tremors, and the seismic regions are distributed as follows:—

Second Western Quadrant—North: Azores, Galicia and N. of Portugal, N. of France, Switzerland, Continental Italy, Central Europe, Eastern Alps, Hungary, Caucasus, 23,962 tremors.

South: Cape Verde Islands, Canary Isles, Madiera, Barbary States, Spain and remainder of Portugal, S. of France (Alpes-Maritimes, Provence, Pyrenees), Balearic Islands, Corsica, Sardinia, Sicily, peninsular Italy, Greece, Balkan Peninsula, Syria, Asia-Minor, Armenia, 50,453 tremors.

First Western Quadrant—North: Eastern Caspian, Syr Daria, Issyk-Kul, Afghanistan, S. side of Himalaya, Assam, Birmania, Thibet, Yunnan, 6,612 tremors.

South: Persia, Beluchistan, Oude and Lahore, Punjab, Hindustan, Ceylon, Andaman, Nicobar, 812 tremors.

First Eastern Quadrant—North: New Zealand (Isle of the N. and Cook's Strait), 1,665 tremors.

South: Australia, Tasmania, remainder of New Zealand, 360 tremors.

Second Eastern Quadrant—South: The Guianas, 25 tremors.

All the rest of the earth's surface, outside these two narrow belts, has only 849 tremors against 148,449; only a twentieth part. There are but three really unstable regions, the Baikal, Kashgar, and basin of Lower Wei-Ho.

Distribution of the seismic regions is not identical along the two zones. In that of the Pacific they are uninterruptedly scattered along an immense arc of 225° (25,600 kilometres) from the Gulf of Ancud (S. Chili) to the Island of Angano (S. of Sumatra). In the Mediterranean zone, on the contrary, they are massed in and pass beyond the circle more extensively to the N. and S. on an arc nearly one-half shorter, only 114° (12,700 kilometres) from the Azores to Yunnan, excepting the independent and isolated centre of instability of New Zealand. The two great circles intersect each other to the S. and off the Island of Paloe-Nias and between the Galapagos and Darien. Their angle is 65° 5′.

The preceding figures ascribe 41.07 per cent. of the tremors to the Pacific circle as against 53.56 for the Mediterranean circle, with a remainder of 5.37 per cent. The difference of 12.49 per cent. in favour of the latter is practically negligible, for it may be due simply to the fact that observations are much more ancient than for the Pacific circle. We may then say that the surface of the earthquakes lies almost solely and uniformly along these two chief lines of relief (relief being the difference of level between the ocean beds and mountain crests), and that these two lines of instability are developed along two great circles forming an angle of 67° with each other.

Standardisation.

Mr. Charles Hawksley's address to the Engineers at the British Association was very largely a workmanlike summary of the recent progress of engineering science, especially in regard to water supply, irrigation, and dam building, but the earlier part of his discourse embraced a valuable reference to "the important work which has been going on quietly and unostentatiously in our midst for some time past—the work of the Engineering Standards Committee." The Committee was appointed in 1901 and now consisted of 178 members, among whom were many Government officials. It had received not only the moral, but the financial support of the Government, and the results of its labours were being adopted by all the leading Government Departments. In addition to the main committee, there were no fewer than twenty-five separate committees and sub-committees engaged in work covering a wide range of operations. Mr. Hawksley added a few details of the work accomplished and in progress. After careful deliberation the Committee had published their first series of British standard sections, covering all rolled steel sections used in constructional work, shipbuilding, and so forth. The Committee on Rails had just issued the standard dimensions and specifications for British girder tramway rails, and was now engaged in drawing up allied standards for certain types of railway rails. Another committee was engaged in drawing up standard specifications and standard tests for cement—a matter of great interest and importance. The Indian Government had referred to the Standards Committee the important question of drawing up a series of standard types of locomotives for use on Indian railways. The committee which had investigated this difficult subject had just forwarded its report to the Secretary of State for India. Other matters for standardisation under consideration were locomotive copper fire-box plates, and steel boiler plates, screw threads, standard flanges, and cast iron pipes; the materials used in the construction of ships and their machinery—an investigation in which most valuable data for future standardisation was being collected—and electrical materials. Mr. Hawksley, while referring to the previous warning delivered before the Institute of Civil Engineers in 1901 against the cramping of originality by stereotyped design, added that the presence of the foremost engineers in the country on the Standardisation Committees was a guarantee that the work would be in accord with the best practice of the country.

The Human Remains in the Edenvale Caves, Co. Clare.

In April, 1902, Dr. Scharff and Mr. R. J. Ussher visited some caves in County Clare, and decided to explore two at Edenvale, near Ennis, which adjoined each other, and proved to be connected. Other caves have since been explored, and interesting remains of extinct animals and human relics have been found in great numbers. The Edenvale ridge of carboniferous limestone forms the western side of a deeply cleft anticlinal; in the chasm thus formed lies a deep lake, surrounded on all sides but one by a steep declivity. The first two caves explored open in a low escarpment on the western side of the ridge. The first cave, after running a straight course for 80 feet, ended in an upward opening, filled in with earth and stones, a material resembling that found in kitchen middens. At 40 feet from the mouth a gallery branched off, connecting it with the second cave at a lower level. A projection in the rocky wall near the mouth of the first cave was worn smooth, as if by the constant rubbing of creatures which had passed in and out. Two strata were generally distinguishable. The upper, a brown earth containing charcoal, bones of man and domestic animals, and various articles such as a bone pin, an amber bead, a bracelet of bronze and of gold. The lower, of clay, contained bones and teeth of reindeer and bear, the latter belonging to individuals of great size.

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Sanitation and Malaria.

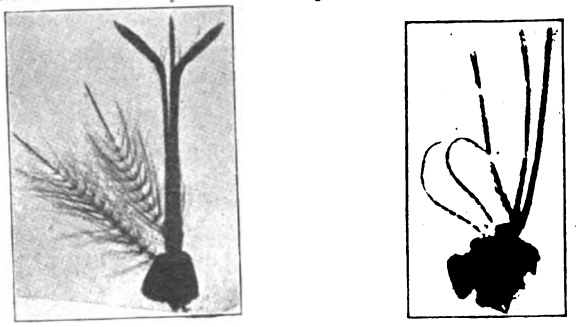
Last month we published an account of the work which was done by Dr. Everett Dutton in the Malaria Expedition to the Gambia. Through the kindness of Dr. Dutton and the Liverpool School of Tropical Medicine we are enabled to publish some photographs from the Report of the state of things existing in Bathurst, which were eminently favourable for the propagation of the mosquito and of malaria. Major Ross, at a farewell lunch given to Dr. Dutton—who, with his colleagues, Dr. Christey and Dr. Todd, is now on his way to the Congo to study the parasite* of sleeping sickness—said that if the British Government would but pursue the study of tropical diseases with the same energy given to it by less interested nations, then, at least, 80 per cent. of the malaria in our colonies would disappear. The instance of energy on the part of a foreign Government which Major Ross had in his mind was that of the United States Government, who, by a vigorous onslaught on the mosquito *Stegomyia fasciata*, have greatly reduced the incidence of yellow fever in Havana; and by a scrupulous attention to sanitary measures have almost rid the locality of malaria. But he might also have quoted the occasion which brought him to the lunch given to Dr. Dutton and his colleagues, for the expedition to the Congo is financed very largely by King Leopold of the Belgians; and nothing towards it is paid by the British Government, although our own sphere of Uganda is devastated by the same disease of sleeping sickness.

The prime necessity in ridding a neighbourhood of the malarial

mosquito is to see that its sanitary state is good. In many malarial localities the ponds and watercourses where the mosquito larvæ can breed dry up in the hot weather. But the larvæ then can take refuge in the stagnant pools, the open drains, the thousand and one insanitary receptacles of water of which the mosquitoes can make use in the wet season as well as the dry. Open spaces of water can be treated by petroleum. For the other places there is no remedy but their destruction. In such places, and even in the standing water in the boats which lie on the beach at Bathurst, Dr. Dutton found *Stegomyia fasciata Anopheles costalis*, *Culex dutteni*, *Stegomyia albocephala*, and *Culex tigripens*.

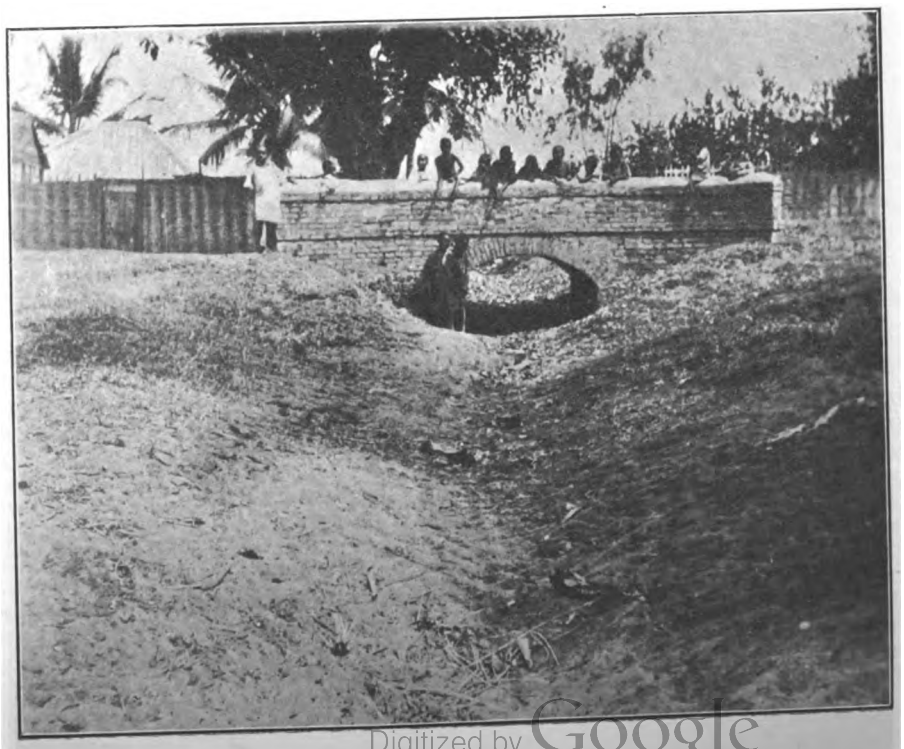
In the street drains were, in addition, *Culex thalassios.* and in the wells *Culex fatigans* and *Culex tigripes*. Our first illustration is a photograph of Llewellyn Street Drain in the dry season. This drain being constructed in sand, with no protection against falling in of the sides, allows of the formation of suitable puddles for breeding mosquitoes. *Anopheles costalis* principally breed in this drain. Water collects underneath the low bridges crossing the drain, in which many mosquitoes are found at the end of the wet season. Our second illustration shows the preliminary filling in of a grass-clogged ditch at Bathurst with old tins, scrap iron, etc., from compounds in the town. The pots and pans themselves were the source of many mosquitoes, chiefly of the *Anopheles* genus. Thus a double riddance is secured and a double purpose served. The last paragraph of the report is a hopeful one, and consists of a reference to a letter received from the resident medical officer at Bathurst, saying that the removal of old pots and pans, etc., throughout the town had been completed, and that the sanitary inspector had now begun his regular weekly inspection of yards and compounds. A gang of men had also started filling in the grass-clogged drains; and the filling in of all the large pools near the cemetery had been accomplished.

We append a head of the male and a head of the female of a variety of the *Anopheles* malarial mosquito.



a Fig. 1.—Anopheles funestus (Giles). b

It is believed that when a mosquito attacks a human being it infuses in the human blood a fluid from its own glands, in order to make the product more suited to its digestion, and that in this mosquito fluid is harboured the malarial parasite which is then transferred to the human being. Some recent investigations by Dr. Celli, in Italy, and other researches in India, seem to show that in some cases, as when the mosquito feeds on acid fruits, its own blood becomes immune to the malarial parasite; and thus, its bite, from a pathological point of view, becomes harmless to man. E. S. G.



* The cause of the sickness, which leads by progressive coma to death, has been attributed by Dr. Castellani to a Trypanasoma found in the cerebro-spinal fluid; but the investigations are far from being complete or conclusive.

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How a Giant Sees.

By Charles E. Benham.

Those in this sceptical age who entertain doubts as to the actual existence of giants with eyes twenty feet or more apart will possibly distrust the statements made here as to their mode of vision; but those of larger faith, who realise that giants, like the fairies in Sligo, "stand to rayson," may possibly be so far interested in the physiology and anatomy of such beings as to listen more patiently. To such readers this article is addressed, with a promise that if they will follow attentively they shall themselves see through a giant's eyes, to the complete confounding of all disbelievers in the historical records preserved in the story of "Jack the Giant Killer" and other well-known classics.

But before this promise is fulfilled it is necessary to enter into a few more or less tedious details of explanation as to the principles of the little instrument—the stereoscope—which will enable us to accomplish our undertaking. And at the same time the reader must start with a clear comprehension of the general principles of our own vision.

Fig. 1.—Cloud Mass as seen by Left and Right Eye of a Giant.

The effect of solidity which characterises our perception of objects by the sense of sight is due to the fact that we look at such objects with both eyes. If we look with one eye only we still retain some sense of the different planes comprised in a scene, but this is only by the suggestion arising from our familiarity with natural forms—our knowledge that such planes accompany any given object or combination of light and shade. That knowledge is derived partly from the fact that we have also the sense of touch, enabling us in many cases to *feel* the existence of such planes when we handle an object, but probably chiefly from our habitual use of the stereoscopic camera of double vision. Even a picture, though of necessity actually in one plane, may by similar suggestion give us an illusion of solidity—not quite equal to that of nature, but almost equivalent when the artist is skilful in tone and accent. Moreover, when two photographs of any given object—one representing it as it would be seen by the right eye, and one as it would be seen by the left—are appropriately placed in a stereoscope, the combined impression of the two plane pictures gives a really complete illusion of solidity in no way short of the appearance of the object itself. The *rationale* of the stereoscopic effect of ordinary vision with two eyes is no doubt (as far as it can be explained) primarily that unvarying experience has always led us to associate such combined optical impressions with the solid objects which give rise to them. For example, ever since we have learned to see at all it has been an invariable experience that, in looking at a cube, one eye will see more than the other does of this or that face of the cube. The combined impression on the brain of these two slightly different images is thus from our earliest infancy associated mentally with what from our sense of touch we know to be a cube. So with other solid forms, and there can be little doubt that in this way our common perception of solidity is to be accounted for as having grown up with the faculty of vision itself, and as being the result of constant association in the mind of certain slightly differing simultaneous impressions in the two eyes with the particular forms that invariably produce those dual impressions. As has been already explained, the photographer takes advantage of this psychological fact to produce stereoscopic photographs, which are simply a pair of photographs corresponding respectively with the slightly differing images of an object formed on the retinas of a pair of eyes. That is to say, he takes two photographs with lenses directed at one and the same object from standpoints differing by about 2½ inches—the distance between the eyes. The stereoscope, by means of its prisms, slightly refracts the photographs, so that each eye, in looking into the instrument, sees its appropriate photograph in the centre of the field of vision, with a consequent perfect stereoscopic illusion, for the brain interprets the two combined images exactly as it would interpret the two identically dissimilar images received by the eyes in looking at the real object.

Fig. 2.—Stereoscopic Sunset.

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After this dry psychological digression it should be quite obvious, from what has been said, that in the case of very distant objects—clouds, mountains, a village far below us in some valley—stereoscopic vision cannot be accounted for by the slight difference of view point of the two eyes. A variation in that view point of only 2½ inches cannot, of course, suffice to produce any appreciable variation in the two retinal images of an object a mile or more away. How then, it will be asked, do we see distant objects stereoscopically? The answer is that we do not. That is one of the ways in which we differ from the giant. He does, because his eyes are so wide apart. As for us poor pigmies, we merely get our idea of the various planes of distant objects from our knowledge of their form, judgment being aided, no doubt, by the degree of distinctness of the objects and the density of the intervening veil of atmosphere. But the duality of the eyes does not assist us in such cases, and it is practically as easy to judge of the planes in a cloud or a distant mountain with one eye as with two.

But how different it is when a giant, whose eyes happen to be, say, 50 yards apart, instead of only 2½ inches, looks at the cloud or the mountain, or the village in the valley. The respective view points of his two eyes differ quite sufficiently to ensure their respective retinal images being appreciably dissimilar. He therefore sees the hollows and projections of cloudland in a way that we have no experience of. To him the trees of the distant hamlet bristle sharply in the landscape, and the rocks and caverns of the far-off mountain all reveal themselves quite distinctly. The whole scene, in fact, appears to our Brobdingnagian friend much as a miniature cardboard model of it would appear to us.

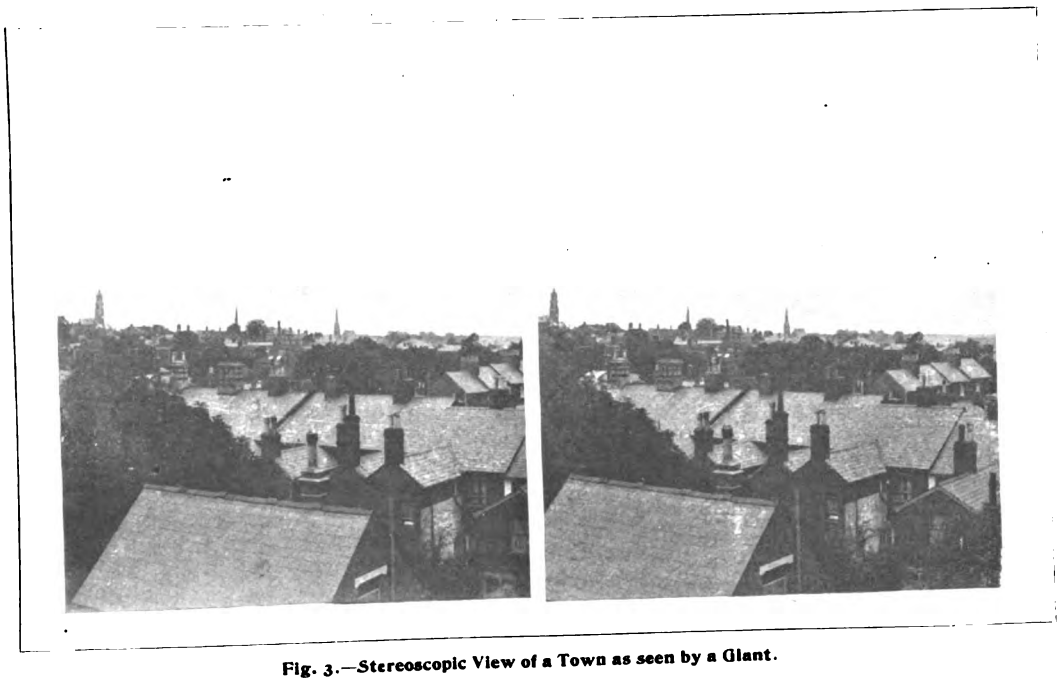


Fig. 3.—Stereoscopic View of a Town as seen by a Giant.

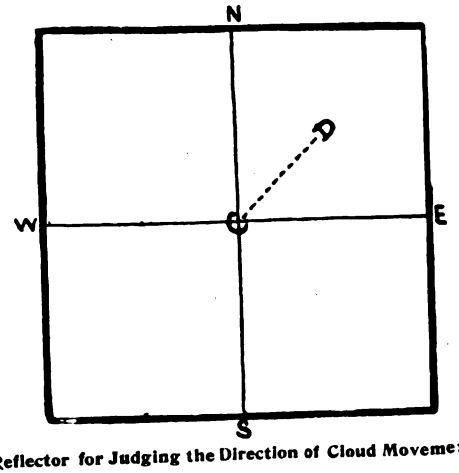
That this is no mere idle speculation as to giant vision we may assure ourselves by the aid of photography. We are concerned in emulating, not the stature of the giant, nor the size of his eyes, but only their distance apart, and this we can easily do by placing two cameras at a similar interval and making a stereoscopic slide of some distant scene as if we were making it for the giant to look at and not for ourselves. The stereoscope will combine the two images in accommodation to our own vision, and thus we shall practically be able to look through the eyes of the giant and see, as he sees, the distant cloud, mountain, or village. Near objects—up to within, say, 100 yards—would present too much difference to combine satisfactorily, and we may perhaps assume that by giants such objects cannot be seen distinctly with both eyes simultaneously unless they squint terribly. We must therefore confine our stereogram to the far distance.

Figure 1 shows such a stereogram of a cloud mass. There are several ways in which such a photograph may be produced. On a still day the cloud may be photographed from a given spot in an open field, and then a second time from some other spot in the field, or two photographers may take it simultaneously with similar cameras from different standpoints. The easiest plan, however, is to "wait till the clouds roll by." That is, to photograph the cloud and then pause a few seconds until the cloud itself has moved into a new position, when a second snapshot is taken on another plate. In these operations the camera must point at right angles to the direction of movement of the cloud. If the cloud is moving to the left the second picture will correspond with a right eye view, and must be mounted on the right hand side for the stereoscope. *Vice versa* if the cloud is moving to the right. If any of the landscape should come into the picture the result would be that the stationary terrestrial part of the view would in the stereoscope seem to be in the foreground, as in the sunset view (Fig. 2), but this discrepancy may be avoided if the photographer, before taking the second picture, moves himself and his camera a few yards, the second standpoint being to the right if the cloud is moving to the left, and *vice versa*. The effect of this is to throw the landscape (as well as the cloud) into relief, and the result is that the terrestrial objects are brought forward in the stereoscope (as in Fig. 1).

It should be mentioned here for the guidance of those who would like to pursue the subject practically, that it is not always an easy thing to decide exactly in which direction a cloud is sailing. The judgment of the eye is not to be trusted, as perspective often gives a false impression. Nor is the weather vane a safe guide, for it by no means follows that the upper currents of wind are identical with those near the earth. The simplest plan is to lay a black glass (see diagram) horizontally, with cross lines marked on the face. Place the eye so that any part of the cloud is reflected so as to appear on the intersecting point of the cross lines, and watch steadily the movement of the reflection, which will correspond with the line of true movement of the cloud. Thus if the cloud reflection C travels along the dotted line C D, the mirror having been adjusted north and south by the compass, the movement is in a north-easterly direction, and the camera must point N.W. or S.E.

Fig. 3 shows a town view as it would appear from the distance to a giant. The two pictures were taken from a height so as to avoid near objects. The distance between the view points of the two photographs was in this case about three yards, so that the effect in the stereoscope may be compared with the view which would present itself to a giant whose height was that of the point from which the view was taken, and whose eyes were nine feet apart.

It will be understood that no idea of the effect can be obtained from the illustrations accompanying this article, except by looking at them through the stereoscope, when it will be seen that in the case of the clouds their actual form is revealed in all its planes in a way that is quite a surprise when seen for the first time, while in the case of the view every building and tree is clearly in relief, the general effect being that of a miniature model of a town. The comparative distances of the church spires and other objects in the distance become manifest in a way strikingly in contrast with the actual appearance of the scene to the eye, which would be altogether unable to detect which of any two objects near the horizon is nearer to the spectator.



Reflector for Judging the Direction of Cloud Movement.

Very interesting stereograms may thus be made by the amateur photographer from almost any hillside or high tower, while the stereoscopic cloud effects are almost telescopic in the revelation they afford of the form and structure of cloud masses, of the constitution of which most people have but little idea.

There is a very simple experiment by which anyone may actually experience "giant vision" in looking at Nature itself. All that is

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required is a dressing table mirror and a small hand mirror. Place the large mirror upright on a table a few feet to your right, and turned at an angle of about 45° with the horizon. Sit level with this mirror and hold the hand mirror at the corner of the right eye, sloping it also at 45°, so that the two mirrors face each other and are parallel. The image from the first mirror is thus reflected by the second to the right eye. At the same time the left eye may look *direct* at the object itself. With a very little adjustment of the hand mirror, the two images will coalesce and form one in high relief like the stereoscopic pictures already described. The positions of object, eye, and mirrors will be understood from the diagram (Fig. 4). Of

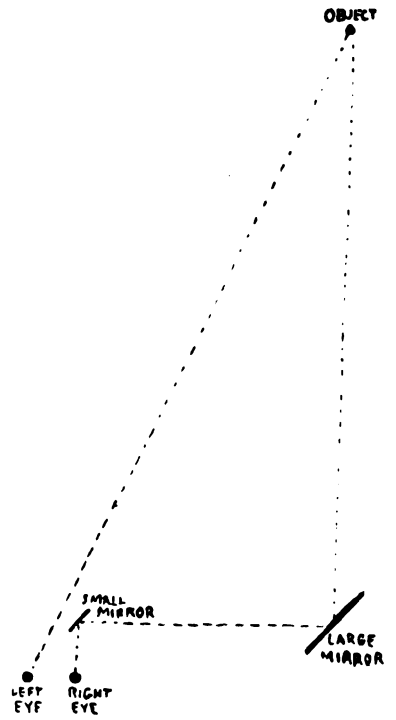

Fig 4.—Arrangement of Mirrors for Experiencing Giant Vision.

course only distant objects must be looked at. The large mirror takes in the view which would be seen by a giant's right eye, the hand mirror accommodating it to the right eye of the spectator, while the left eye sees the same object from an appropriately separated view point. In this way even clouds, if not very distant, have their solid form revealed to a considerable extent, while objects in a distant landscape, though of course not magnified, are seen much more definitely and distinctly than they are in ordinary vision.

The principle roughly applied in this arrangement of mirrors may be more scientifically carried out by constructing what might be termed a gigantoscope, in which four mirrors—two for each eye—are arranged in a tube, or on a long board, as shown in Fig. 5

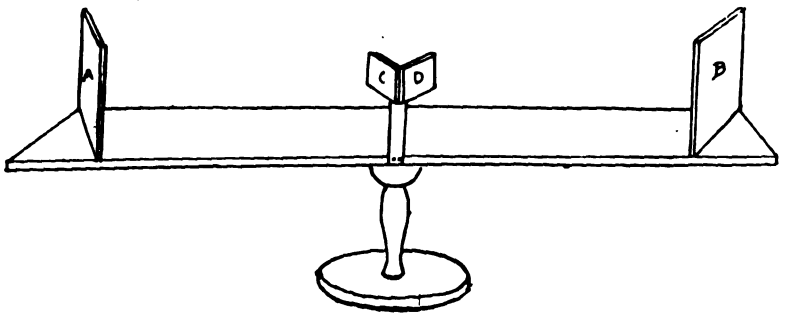

Fig. 5.—The Gigantoscope.

A and B are two large mirrors set wide apart and sloping at 45°. C and D are the two small eye-piece mirrors which receive the reflections from A and B and direct them to the left and right eye respectively.

[It should be mentioned that owing to the impossibility of reproducing the soft cloud effects in tone-block prints the illustrations of the stereoscopic slides give only a faint idea of the originals.—C. E. B.]

Tobacco for the Young.

A GERMAN chemist, Herr Gerold, has discovered a means of preventing the ill-effects which sometimes arise from the excessive use of tobacco, which is liable to produce attacks of vertigo, a particular form of dyspepsia, palpitation, and diseases of the chest. His procedure consists in steeping the leaves of tobacco, before being made up, in a solution of tannic acid, which combines with the nicotine and forms a substance quite inactive and harmless. In order to increase the flavour of the tobacco, it is then treated with a decoction of marjoram. The flavour of the tobacco prepared as above described differs in no way from that of ordinary tobacco; and experiments made with it on weasels, frogs, and even human beings, have demonstrated that its use produces no toxic effects on the organism. The pressure of the blood remains normal, the heart beats regularly, and the paralysis which overtakes animals who have been poisoned with nicotine is entirely obviated.

A Butterfly Mart.

By PERCY COLLINS.

NOT the least curious and instructive of leisure time hobbies is foreign butterfly collecting. A few years ago the entomological dilettante confined himself to the insects that he was able to capture in English lanes and meadows. To-day, he has widened the field of his investigations, and collects the butterflies of the world—not, indeed, by going

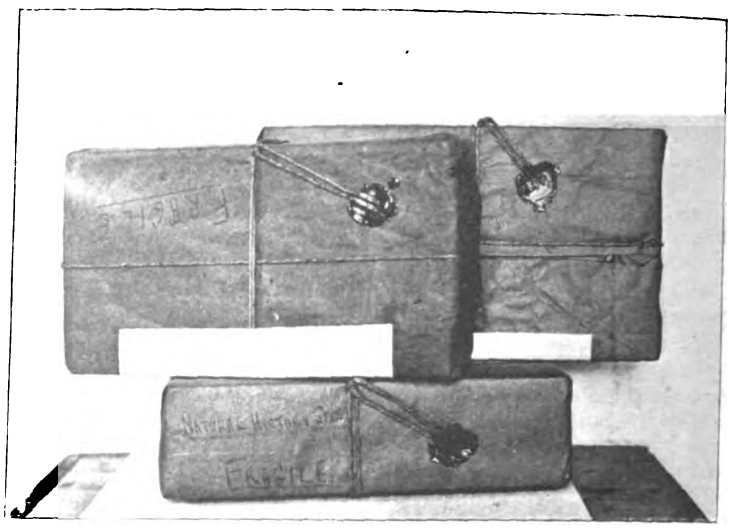

Fig. 1.—Butterflies are sent from Abroad by Post, usually packed in small Cigar boxes.

abroad himself to capture them, but by the employment of agents and dealers.

Naturally, such conditions have led to the formation of a regular butterfly market, with its current prices and quotations, in which butterflies are bought and sold like silks or groceries. Thus, there are bargains in butterflies, which may be purchased at so much for the dozen or the gross; butterflies worth their weight several times over in gold or bank notes; while Mr. Stevens, the well-known auctioneer of curios, holds special sales, at which nothing but butterflies come under the hammer.

But let us step into the show-room of our friend the butterfly dealer, and ask him to favour us with a sight of his stock. No artist's colourman has half the tints at his disposal that are seen on

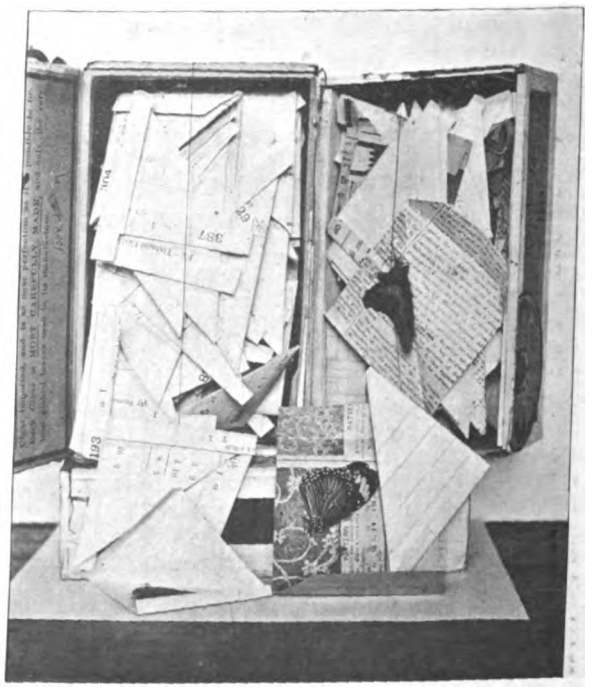

Fig. 2.—These, when opened, show the Insects packed flat in three-cornered Paper Envelopes.

the wings of tropical butterflies. Here are glorious examples from Brazil, shining with bands of iridescent blue. Yonder are some from the far Pacific Islands, whose velvet wings are slashed with fillets of shining green or gold. While in a third case are insects so grotesque and extraordinary in form, that the mere sight of them prompts an enquiry as to what end such remarkable shapes can serve.

The butterfly dealer shakes his head. Very little is known, he tells us, of the life and habits of his specimens. The economy of a few has been studied; but in the majority of cases, the subject is shrouded in mystery. Yet butterflies are of such entrancing beauty that many people collect them for that reason alone. At least one society lady has lined the walls of her boudoir with cases of butterflies, fetched from every corner of the world. Nor is it unheard of that the impersonator of some character at a fancy dress ball should

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seek the aid of the butterfly dealer. Carefully prepared specimens, specially mounted and strengthened, are supplied as ornaments for the

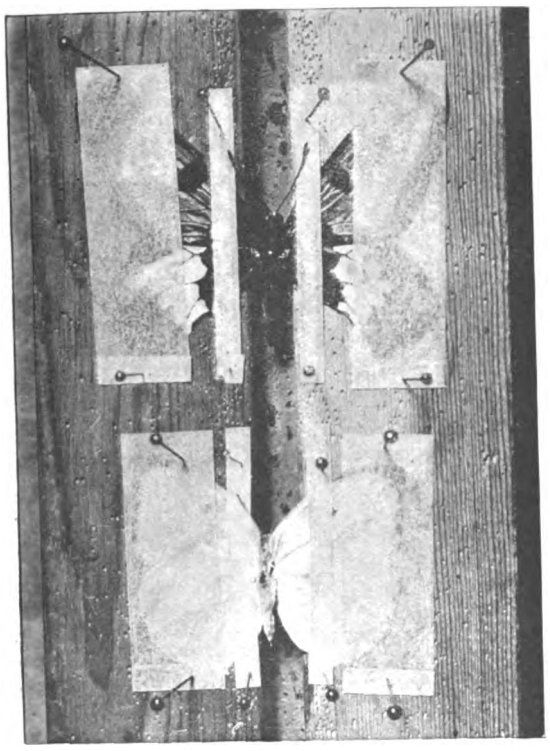

Fig. 3.—The Specimens are "relaxed" in a Moist Atmosphere, and then pinned out, "set" on Special Boards. Here they must remain, with their Wings strapped into position, for several weeks.

dress and hair. And in the brilliantly-lighted ball-room they flash and glow like so many jewels.

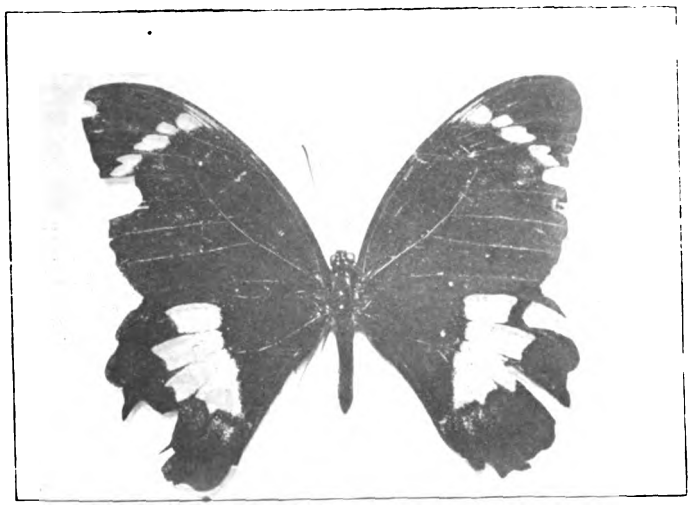

Fig. 4.—Sometimes the Entomologist finds a Specimen that is very badly damaged.

But how are all these butterflies brought together? Where do they come from, and who catches them? They are brought from all

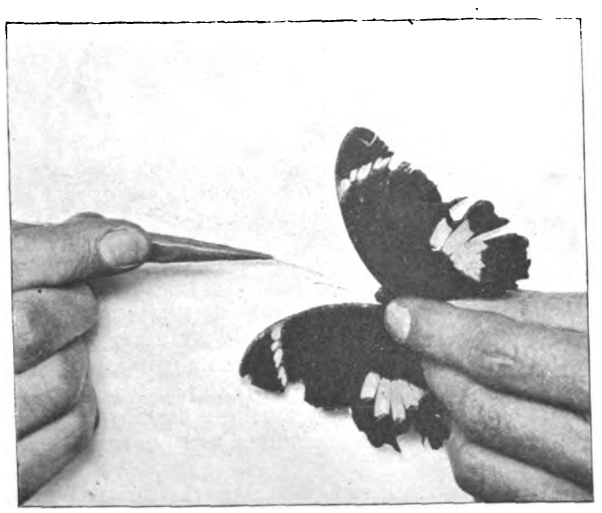

Fig. 5.—The Missing Feelers are replaced.

parts of the world—north, south, east, and west, but principally, of course, from tropical regions. No spot is so remote or wild but collectors yearn to add examples of its insect fauna to their cabinets. Indeed, the wilder and more uncivilized the locality, the greater the demand for the specimens that are brought from it. It is just these little visited corners of the earth which yield the rarities.

The life of the professed butterfly hunter, the man who wanders to far distant islands in search of specimens, is not always an enviable

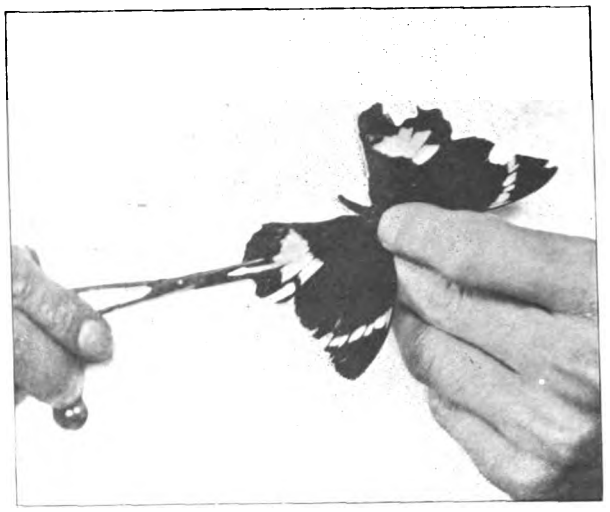

Fig. 6.—The Wings are carefully mended.

one. Several years ago, a very handsome and large butterfly was discovered in the interior of New Guinea. It is a resplendent creature, richly adorned with green and gold, while each hind wing terminates in a quaint tail-like appendage. A German collector was the first

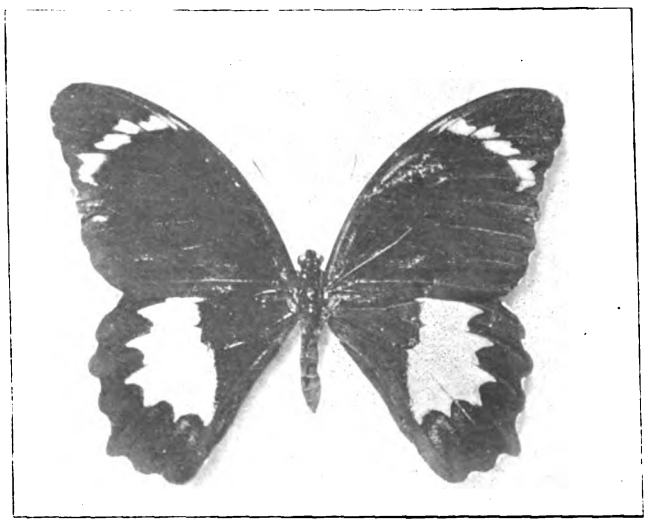

Fig. 7.—And the Butterfly comes out from Hospital, looking almost as perfect as on the day of its birth.

white man to see this butterfly. He found it while wandering on the densely-wooded slopes of the Finisterre Mountains, 1,200 feet above the sea level; and after infinite patience and trouble managed to secure several perfect examples.

But the unfortunate man was denied the satisfaction of bringing

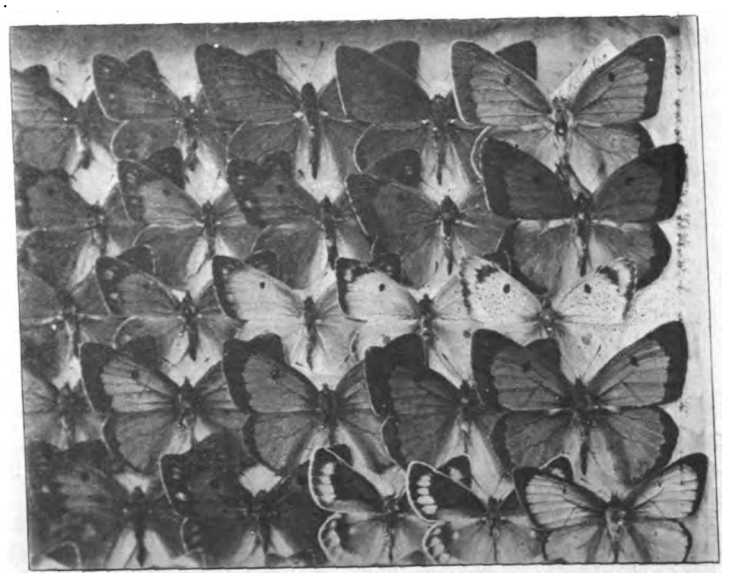

Fig. 8.—Butterflies packed tightly one over the other in Box lined with Cotton Wool, for Travelling.

home his unique captures. He fell into the hands of the savage Papuans, and was not only done to death, but became a victim to their cannibal propensities.

After a long interval a portion of the dead man's baggage was

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brought to the coast, and with it came the butterflies. These were eventually forwarded to the late Doctor Staudinger, of Dresden, who was at that time the biggest butterfly dealer in the world. He named the insects "bird-winged butterflies of Paradise," and sold them at very high prices. One private collector paid £25 for a single male specimen.

Butterflies are imported in three-cornered paper envelopes. The dealer opens a box of these little packages for our inspection. For the

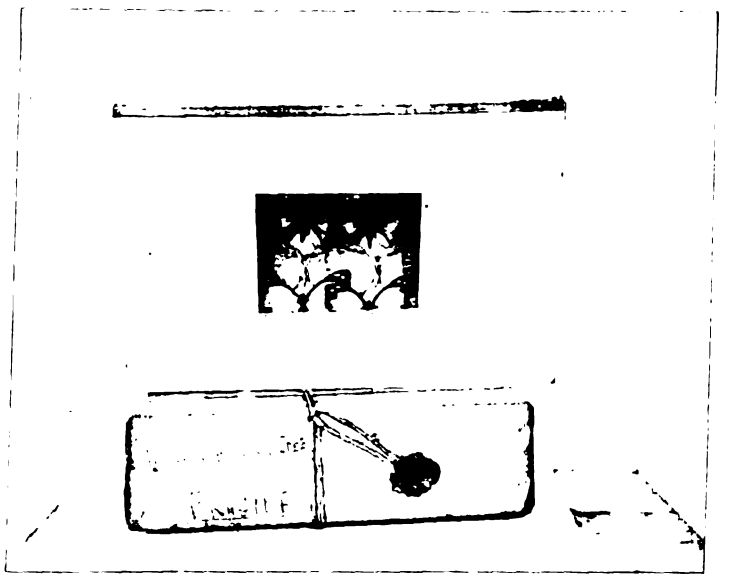

Fig. 9.—The Foreign Travel Box has a Window in its Lid. This allows the Customs Officers to examine the contents of the Box without opening it.

journey they are packed flat in an old biscuit tin, or a cigar box, and sent by post. In this manner it is possible to receive butterflies in England as fresh and perfect as on the day of their capture.

The mere importation of butterflies, however, constitutes only a small portion of the dealer's work. Each specimen must undergo treatment, and be pinned and mounted after an approved method. This work is often undertaken by ladies, whose deft fingers enable them to become very proficient butterfly mounters. When the butterflies have been prepared, or "set," they are taken over by the dealer, who sorts, names, and labels them. Of course, a certain percentage of the specimens are found to have sustained more or less injury. These, if they are rare butterflies, must undergo hospital treatment. Patches are carefully put into the wings, legs and feelers are replaced, and the whole is made to look as much like nature as possible. It

Fig. 10.—A Bevy of Butterflies, suitable for Decorating the Hair.

goes without saying that butterfly-mending is a difficult art. Only the oldest hands are capable of turning out these patched specimens in a workmanlike manner.

Pressed in the matter, the butterfly dealer admitted that the postal authorities are—if not the bane of his life—at least a fruitful source of anxiety. But years of patient scheming have done much towards perfecting his packing arrangements. The butterflies are placed one over the other in boxes lined with cotton wool, so that each, as it were, clips its neighbour into place. Then the boxes actually containing the insects are packed into stronger boxes, or travelling trunks, and in this way specimens are sent, not only to all parts of the British Islands, but even to the Continent, to Canada, and to the United States.

Butterflies that are sent out of England are often packed in specially-made boxes with squares of glass let into the middle of the lids. This precaution is adopted in view of the Customs examination. The officer is able to examine the contents of each box in search of dutiable articles without opening it. So that these little glass windows prevent a great deal of damage.

As is the case with other saleable objects, the price obtainable for butterflies varies. At Stevens's hundreds of bright, showy specimens are sometimes knocked down for a few shillings. But, as the

Fig. 11.—It is said that the celebrated silk Indian and Cashmere Shawls were woven in imitation of this Butterfly's Wings.

dealer sagely remarks, there are butterflies and butterflies. Rare specimens that are on the "wanted" list of museums and private collectors always command high figures. And for these plums the dealer is ever on the alert.

The exceedingly high prices often asked and paid for butterflies are rendered possible by the extreme uncertainty of the market. There is no means of knowing how long a butterfly will remain a rarity. It may continue unique for a quarter of a century, or it may become common in the course of a few months. A case in point is that of a beautiful blue butterfly from Brazil. When the first specimens of this butterfly were sent to England, years ago, they sold readily for £10 or more apiece. Since then, however, collectors have sent it

Fig. 12.—The West African Goliath Beetle—the Biggest Beetle known.

home in numbers, and the price has fallen to a paltry five shillings.

Butterflies are by no means the only insects for which a market exists. Of late years private collectors have developed an interest in all kinds of quaint and curious creatures such as scorpions, beetles, and spiders.

Perhaps the grandest insect known is the huge West African Goliath beetle. Sixty-eight years ago a writer described this remarkable insect from a single example preserved in the Hunterian Museum at Glasgow. To-day, the insect is imported from the Cameroons literally by the hundred specimens, packed in sawdust like grapes or oranges. The great size of these specimens—large ones measure as much as four and a half inches from head to tail—has made them popular as curiosities.

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How the Sun's Temperature is Determined.

By W. E. Wilson, F.R.S.

The usual method of determining the temperature of any hot body, such as a vessel of warm water, an oven, or even a furnace if it is not too hot, is to put a thermometer into it and read the height of the liquid in the stem of the instrument. This method is evidently impossible in the case of the Sun. The only other method by which we can at present hope to measure the solar temperature is to measure the amount of radiation coming from the Sun, and then by comparing this to the radiation from a hot body such as the inside of a furnace, the temperature of which can be determined.

When we wish to use this method we must first determine the law which connects Temperature and Radiation. If we stand in front of a fire we feel the radiation from it on our face, and as the fire gets hotter, or, in other words, as the temperature rises, we feel the radiation increasing. Now, suppose the temperature of the fire was doubled, should we feel the radiation doubled? Is the radiation directly proportional to the temperature? Newton, from some measures he made through a small scale of temperature, concluded that this was the law, but modern investigations over wide ranges of temperature have shown that the radiation increases much more rapidly, and is proportional to the fourth power of the temperature. So that if the temperature was *doubled* the radiation would be increased *sixteen times*. This law, which was first determined by Stephan and which is expressed by the formula $R = aT_4$, has been amply confirmed by the most elaborate methods of research.

Next in importance to the law we adopt for radiation is the instrumental means of measuring its amount.

In 1893 I undertook this research in my laboratory, and again in 1901 with improved apparatus.* The instrument employed by me was a modification of Professor Boys's Radio-micrometer. It was made of a duplex form so that it could be used differentially. That is to say, that the two thermo piles were so coupled together that when radiant heat of the same intensity was allowed to fall on both of them simultaneously the instrument remained at zero.

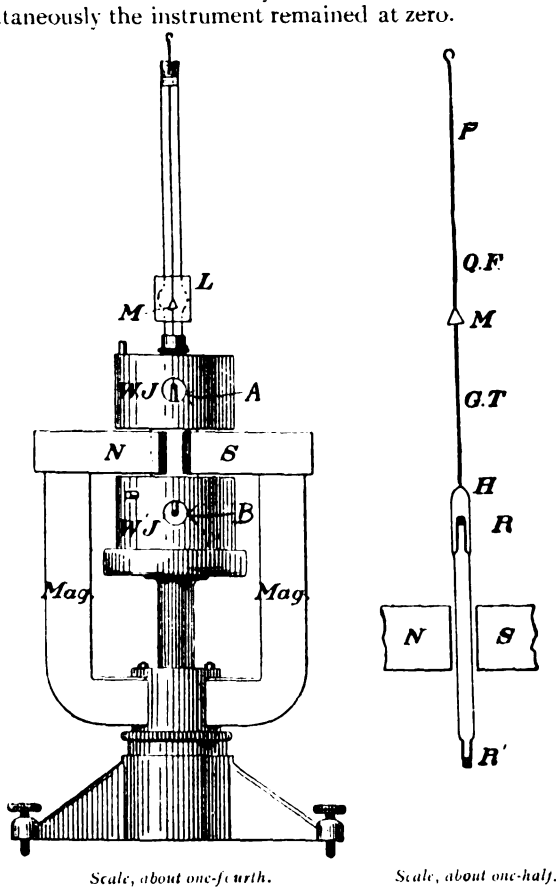

Fig. 1.—The Differential Radio-micrometer and Circuit.

The instrument is shown in elevation in Fig. 1 on a scale of about ¼, while the thermo piles and circuit are shown about ½ size on the right of the figure, where R and R1 are the two receiving surfaces of blackened copper foil, attached to which are the two minute bars of bismuth and antimony, which constitute the thermo pile. The two pairs of bars are connected by a circuit of fine copper wire, and the whole system is supported by a hoop H of similar wire (from which, of course, it is insulated), to a fine glass tube G.T., to which is fastened the mirror M. The entire system, which only weighs 1½ grains, is suspended by a quartz fibre Q.F., which is attached to a pin P, which passes through a cork as shown in the quarter-scale drawing. In the elevation of the complete instrument, Mag. denotes the magnet, N. and S. the pole pieces between which the circuit hangs inside a hollow block of brass; this shields the thermo piles from all radiant heat except what is allowed to fall on them through the apertures A and B. A beam of light was reflected off the small mirror M on to a scale at a distance of a metre. Now, suppose one of the apertures A closed and radiant heat allowed to fall on one of the thermo piles through the other aperture B, this heat causes an electric current to be set up in the loop of copper wire which is attached to the piles, and the current causes the entire system, as it is suspended between the poles of the magnet, to turn through a certain angle. This motion is shown and measured by the

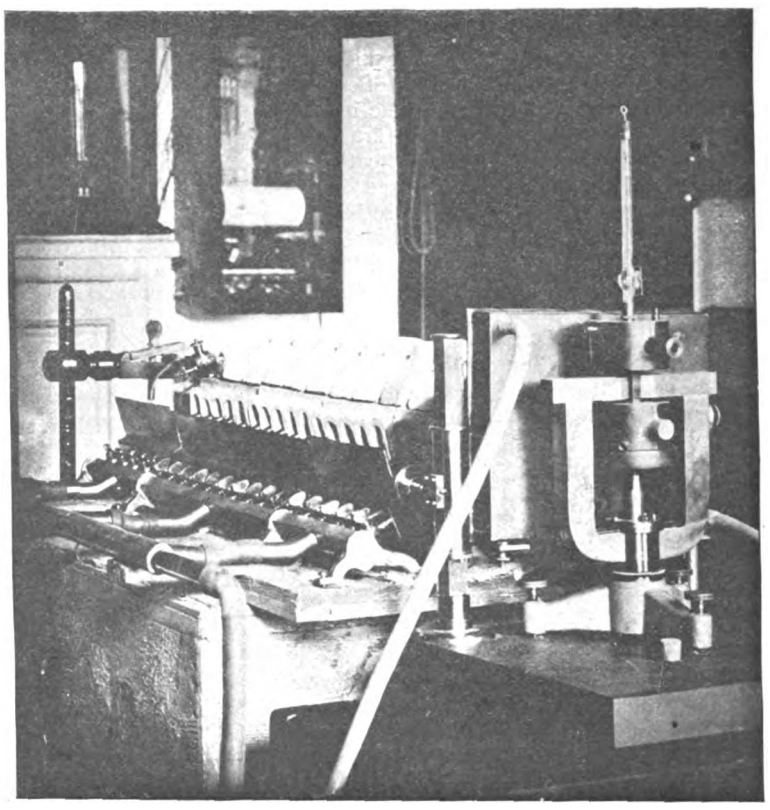

Fig. 2.

movement of the beam of light reflected on to the scale from the little mirror M. If we now open the other aperture A and close B and allow the same radiant heat to fall on A, the spot of light will move along the scale but in the opposite direction, or if we open both apertures together so that the same amount of heat falls on both piles, the spot of light will remain steady at zero. The instrument was of such sensibility that the heat coming from the naked hand at a distance of six feet moved the beam of light through 50 divisions along the scale. We have, in fact, in this instrument, a heat balance by which we can measure the relative intensity of two beams of radiant heat. In this particular research the two beams which we wish to measure are, that coming from a hot body heated in a furnace, the temperature of which is *known*, and a beam coming from the Sun, the temperature of which is *unknown*, but is to be determined.

The amount of heat that hot bodies are able to radiate depends not only on the temperature, but on the state of the surface. If the surface was perfectly black they would be able to radiate the maximum amount of heat, but if the surface was perfectly polished they would not radiate at all. Thus, if we wish to keep our tea hot, we should put it in a well-polished silver tea-pot, whereas in a dull black tea-pot the tea would get cold much more rapidly, because it will lose a large proportion of its heat through radiation.

We have reason to believe that the Sun radiates its heat as if it was a perfectly black body, and, therefore, in balancing its radiation we must use the radiation from a similar body like lamp-black, or, better still, the radiation coming from an aperture in the walls of a hot enclosure. In 1895 Mr. F. Lanchester showed that such an enclosure would behave as a *perfectly black body*. We therefore have in such an apparatus a source of radiation which acts as a perfectly black body such as we conclude the Sun to be.

The most convenient way of making this hot enclosure was by putting a piece of iron pipe about two feet in length and one inch in diameter into a gas furnace by which its temperature could be maintained at about 1,000° C. Projecting into the tube at one end was a Callendar electric platinum thermometer, by which the temperature of the interior of the tube could be determined with accuracy. Opposite the other end of the tube was a brass screen through which a current of water was circulated so as to keep it cool. In the centre of this screen was an aperture looking into the interior of the hot tube in the furnace, and behind the screen and opposite this aperture was placed one mouth of the radio-micrometer. The aperture in the screen was provided with a small sliding door which could be opened or closed by a micrometer screw. By reading the divisions on the head of this screw the size of the opening in the screen could be measured.

Now, to determine the Solar Temperature the radio-micrometer

*Wilson and Gray. The Effective Temperature of the Sun. Phil. Trans., A, vol. 185 (1894.) W. E. Wilson. Proceedings of the Royal Society, vol. 69 (1901).

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was erected on a concrete pier in the laboratory, and close in front of one of its mouths was placed the brass water screen with its little sliding door looking into the open end of the intensely hot iron tube in the furnace. A heliostat was placed outside the window of the laboratory and it directed a beam of sunlight into the other mouth of the radio-micrometer. The spot of light reflected from the little mirror M then moved off the scale in one direction or other, and the little sliding door in the water screen was next adjusted until the spot of light returned to zero. The divisions on the micrometer screw were then read, and gave us the size which the aperture admitting the radiation from the furnace required to be to allow the same quantity of radiant heat to reach one thermo pile as was being received from the Sun by the other pile. A series of observations were thus taken, and then the order of things was reversed; that is to say, the Sun was allowed to shine into the aperture that previously received the radiation from the furnace, and the radiation from the furnace was likewise directed into the other aperture. An equal number of observations were taken in this position. The mean of all these observations in the two series then gave data for calculating the true effective temperature of the Sun.

The apparatus, as it was arranged in the laboratory, is represented in Fig. 2, where the radio-micrometer, with the water screen and the gas furnace behind, can be seen.

Before the final result can be obtained from these figures there are some modifying factors which have to be calculated. These are: 1st, the amount of heat which is absorbed by the Earth's atmosphere and which varies with the Sun's altitude; 2nd, the amount reflected by the glass mirror of the heliostat, and which varies with the angle of incidence.

The following table exhibits the result of one complete series of observations and the method of reducing them. In this, Rosetti's value for the amount of the terrestial atmospheric absorption has been used, which is equal to 29 per cent., when the Sun is in the zenith.

The successive columns of the table contain: (1) The local mean time. (2) The width of the opening in the screen as determined by the micrometer screw, its height being 7 m m. (3) The absolute temperature of the tube in the furnace. (4) The Sun's altitude. (5) The percentage of the Sun's radiation transmitted through the Earth's atmosphere. (6) The angle of incidence on the heliostat mirror (7) The percentage of heat reflected from the surface of the mirror. (8) The corresponding value of the Sun's effective temperature.

Note, $a = 7$ mm.

Local time.		Balance. Reading.	Balance. Temp. absolute.	⊙ Altitude.	Per cent. trans.	Angle of incidence.	Per cent. reflected.	⊙ Temp. absolute.	Date, August 19, 1903. Blue sky.
h.	m.		°	° ′		°		°	
11	0	1·68	1099	47 18	66	62	9	5586	First Position (B)
11	3	1·69	1098	47 36	66	62	9	5589	,,
11	7	1·70	1098	47 44	66	62	9	5598	,,
11	19	1·60	1100	48 24	66	62	9	5593	,,
11	22	1·55	1100	48 25	66	62	9	5459	,,
11	28	1·62	1101	48 41	65	63	11	5161	,,
11	30	1·70	1101	48 42	66	64	12	5223	,,
11	33	1·75	1101	48 50	66	64	12	5262	,,
11	36	1·77	1101	48 54	67	64	12	5278	,,
11	38	1·80	1101	49 0	67	64	12	5286	,,
							Mean	5394	,,
12	48	3·99	1119	48 20	67	68	15	6192	Reversed P't'n (A)
12	51	4·00	1119	48 13	67	68	15	6184	,,
12	53	3·98	1119	48 6	67	68	15	6186	,,
12	56	3·96	1119	48 0	67	68	15	6190	,,
12	58	3·98	1119	47 49	66	68	15	6210	,,
1	3	3·94	1119	47 39	66	68	15	6193	,,
1	5	3·93	1119	47 36	65	68	15	6190	,,
1	7	3·93	1119	47 24	66	68	15	6190	,,
1	9	3·92	1119	47 18	66	68	15	6186	,,
1	11	3·96	1119	47 13	66	68	15	6202	,,
							Mean	6192	,,

Geometrical mean of A and B = $\sqrt{5394 \times 6192} = 5779°$.

The effective temperature of the Sun as deduced from this series of observations works out at 5,779° absolute. Subsequent observations modified this result to a very slight extent, the result deduced from the whole series amounts to 5,773° absolute.

Astronomical Notes for October.

The Sun.

On the 1st the Sun rises at 6 h. 0 m. a.m., and sets at 5 h. 40 m. p.m. On the 15th he will rise at 6 h. 24 m. a.m., and set at 5 h. 8 m. p.m. The length of the day is therefore 11 hours 40 minutes at the beginning, and 10 hours 44 minutes at the middle of the month. Daybreak occurs on the 1st at 4 h. 8 m. a.m., twilight ending at 7 h. 32 m. p.m. The Sun's apparent declination at noon on the 1st will be 2° 49′ 48″ south, the hourly variation being 58″·31; his right ascension on the same date being 12 h. 26 m. 11 s., with an hourly variation of 9 04 secs.

The Moon.

The Moon will be full on the 6th at 3 h. 24 m. p.m., her last quarter occurring on the 13th at 7 h. 56 m. p.m. She will be new on the 20th at 3 h. 30 m. p.m., and attain her first quarter by the 28th at 8 h. 33 m. a.m. Our satellite will be in perigee on the 16th, and in apogee on the 28th.

The October full Moon is popularly known as the "Hunters' Moon," as it, to a large extent, bears the same attributes as the "Harvest Moon" of September, inasmuch as, rising when full at 5 h. 32 m. p.m., she rises but about half-an-hour later for several successive nights, and was therefore considered useful for the huntsmen returning in the short Autumn evenings.

At the time of last quarter our satellite will rise at 10 h. 34 m. p.m. At first quarter she will set at 11 h. 13 m. p.m.

A partial Lunar Eclipse will take place on the 6th, but as the Moon does not rise at Greenwich till 5 h. 32 m. p.m. on that date, as previously stated, the last contact with the shadow having taken place 37 minutes previously, this phenomenon is not of much interest to observers in the United Kingdom.

Occultations will take place (1) on the 6th, when *e* Piscium (magnitude 5·7) will disappear at 11 h. 31 m. p.m., at 55° from the true north point, and reappear 1 hour and 17 minutes later at 257° from the T.N.P.; (2) on the 10th, when *a* Tauri (Aldebaran, mag. 1·1) will disappear at 8 h. 18 m. p.m., at 83° from the T.N.P., and reappear at 9 h. 11 m. p.m., at 257° from the T.N.P.; (3) on the 15th, when A^1 Cancri (mag. 5·6) will disappear at 2 h. 56 m. a.m., at 173° from the T.N.P., and reappear 19 minutes later, at 207° from that point; and (4) on the 30th, when ρ Aquarii (mag. 5·3) will be occulted at 7 h. 10 m. p.m., at 3° from the T.N.P., and reappear at 7 h. 46 m. p.m., at 311° from the point mentioned. The occultation of *a* Tauri is noteworthy as being that of a *first magnitude* star, but although rather unusual, this circumstance cannot be called *rare*, as this same star—*Aldebaran*—will, in 1904, be occulted no less than *four* times during the year.

The Moon will be in *conjunction* with Saturn on the 1st, Jupiter on the 4th, Venus on the 17th, Mercury on the 19th, Mars on the 24th, Saturn again on the 28th, and with Jupiter also for a second time on the 31st.

The Planets.

Mercury does not come into observation until the last half of the month, but from the 15th to the 22nd he is especially well placed for the observer in the early morning hours, rising a little north of east at 4 h. 42 m. a.m. on the first named date, and at 4 h. 49 m. a.m. on the last. The planet will be at his *greatest elongation west* (18°) at 3 h. a.m. on the 19th, and this is the most favourable opportunity of the year for his observation as a "morning star." On the 18th his R.A. will be 12 h. 24 m. 7 s., and his S.D. 0° 41′ 40″, and he will show an apparent diameter of 7″·0.

Venus is now a "morning star," rising on the 15th at 3 h. 21 m. a.m. On the 28th she will rise at 2 h. 52 m. a.m., and the planet's R.A. on that date will be 11 h. 28 m. 24 s., and her N.D. 1° 40′ 47″. The apparent diameter of her disc will be 37″·0 at the end of the month, her *greatest brilliancy* being attained for the second time this year at midnight on the 24th.

Mars may be considered as completely "out of the running" for the present as far as amateur observation is concerned, as he sets only about 2 hours after the Sun, has a *southern* declination of over 24°, and presents us a disc but $5\frac{1}{2}''$ in diameter.

Jupiter now becomes suitable for observation in the early evening, and still appears as a fine object in our south-eastern and southern skies. On the 1st he rises at 5 h. 4 m. p.m., presenting a disc of about 45″ in diameter. On the 28th his R.A. will be 23 h. 2 m. 5 s., and his S.D. 7° 46′ 4″, and he will then *south* as early as 8 h. 38 m. p.m.

Saturn's southern declination again increases this month, and becomes over 20°. This, coupled with the fact that his apparent disc diminishes to 15″·6 by the 28th, and also that he *souths* before 6 h. p.m. on that date, causes him to be a much less interesting object than of late. On the 8th his R.A. will be 20 h. 20 m. 33 s., and his S.D. 20° 13′ 53″. The planet will be in *Quadrature* on the 27th.

Uranus is still situated in the constellation Ophiuchus, but is now nearing *conjunction* with the Sun, and sets as early as 6 h. 57 m. p.m. on the 28th, with R.A. 17 h. 29 m. 22 s., and S.D. 23° 25′. His apparent diameter will be 3″·4.

Neptune, on the contrary, is approaching *opposition*, and is therefore becoming gradually more favourably situated for the observer. At the end of the month he rises at about 8 h. p.m., with a disc whose apparent diameter will be 2″·6. His R.A. on the 28th will be 6 h. 25 m. 20 s., his N.D. being 22° 15′.

The *minor planet* Vesta is now approaching *opposition*, and therefore becoming suitably placed for observation. On the 31st she rises at 6 h. 41 m. p.m., with R.A. 4 h. 34 m. 22 s., and N.D. 13° 57′ 15″.

The Constellations.

Pegasus (the "Flying Horse") is now on the meridian as we gaze southward, above which Andromeda, a little to the eastward of the line mentioned, spreads herself longitudinally across the sky. The stream of water which Aquarius is supposed to be pouring over his shoulder now flows down to Piscis Australis, on the southern horizon. The new constellations rising in the east or north-east, as we turn from south to north, are Orion, Taurus, Auriga, Gemini, and Lynx, and includes the well-known star-cluster of the Pleiades.

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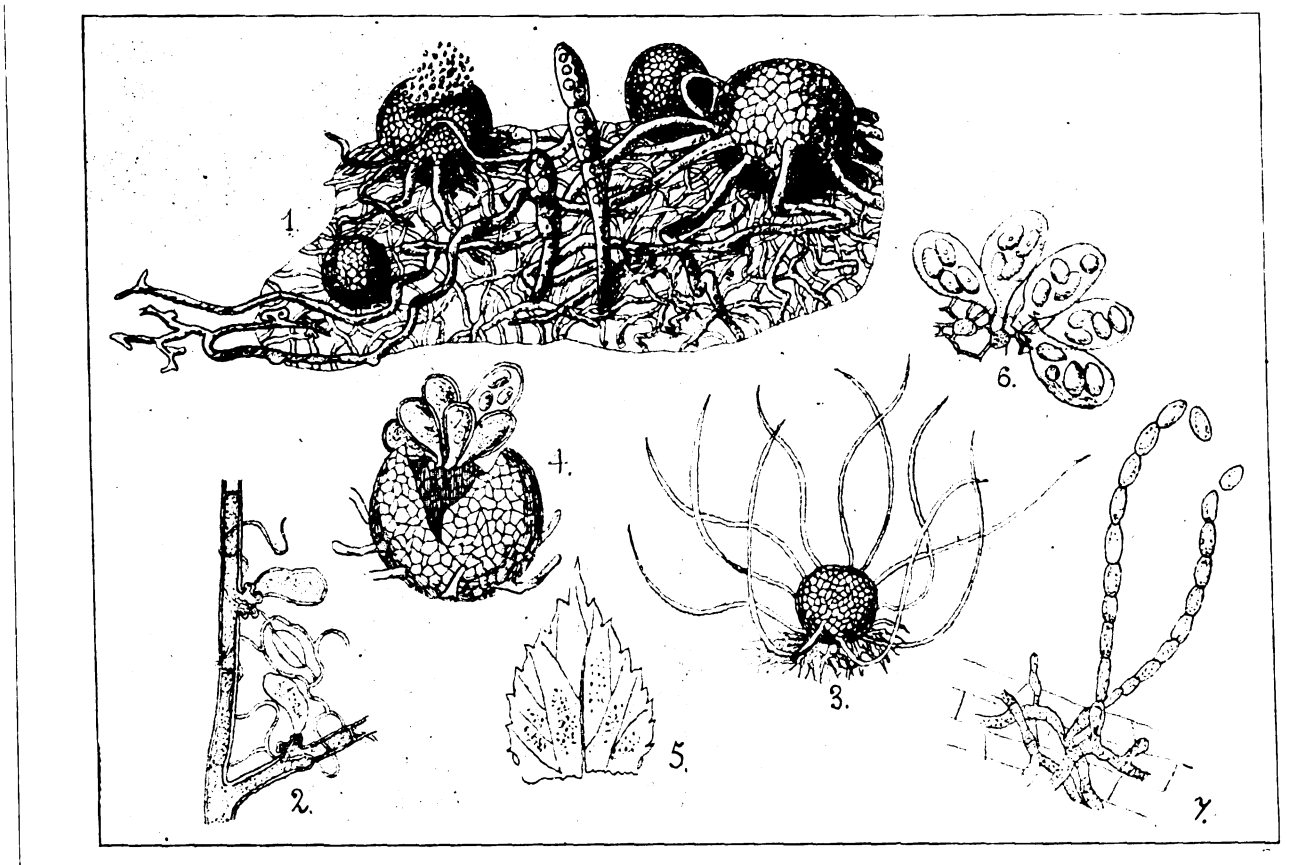
The Infection of Plants by Mildews.

In the course of a country walk we may frequently—especially in somewhat moist situations—observe that the leaves of a number of the plants are covered by a delicate white web, and a closer examination will often reveal numerous little black bodies, scattered in amongst the former (Fig. 5). The white web is due to the occurrence of numerous fungal hyphæ, constituting the mycelium or vegetative body of a mildew (Fig. 1. showing mycelium on leaf-surface, enlarged), and the little black bodies, which will be found to be directly attached to some of the hyphæ, are the fructifications (perithecia, Figs 1 and 3), in which the characteristic spores (ascospores) of these fungi are contained (Fig. 4). These spores do not lie freely in the cavity of the perithecium, but are contained to the number of (generally) eight in several little sacs (the asci; Fig. 6 showing a group of asci with contained ascospores). The white mycelium creeps about on the surface of the host-plant in all directions (Fig. 1), sending out numerous short branches (the haustoria; Fig. 2 shows a small portion of the mycelium with haustoria, much enlarged) into the epidermal cells of the latter; these



branches, the only part of the fungus that in the case of the mildews enters into the body of the host, serve to take up nourishment from the same. In addition to the ascospores, which are thick-walled and ordinarily go through a period of rest before germination takes place, thin-walled spores (called conidia) are formed in long chains on upright branches of the mycelium (Fig. 7).

The conidia are readily blown away by the wind, and if they come into contact with another host-plant they will, under suitable conditions, germinate and form a new mycelium. There are a considerable number of different species of mildews, and the large majority of them are known to be capable of existing on a number of plants, belonging sometimes to different genera or even to different orders. Now, it is a remarkable fact that, although it is absolutely impossible to detect any morphological difference, some of the forms of one and the same species occurring on different host-plants are evidently physiologically distinct; for it has been shown that the conidia of a species, inhabiting a certain host-plant, are incapable of infecting a number of the other plants on which the same species occurs. Thus, the conidia of the mildew, occurring so commonly on grasses (*Erysiphe graminis*), if gathered from an individual growing on *Bromus arvensis*, will fail to germinate on certain other species of brome grass, as well as on wheat and oats; and, inversely, conidia from any of these latter will not germinate on *Bromus arvensis*. On the other hand the conidia from any one host-plant are not alone able to infect that one, but will generally also germinate readily on a number of different host-plants. A further interesting feature is that, although the conidia from an individual growing on a host-plant A may be unable to directly infect a host-plant B, if they are transferred to another host-plant C, on which the conidia from A can germinate and form a mycelium, and the conidia formed on C are then transferred to B, infection in some cases takes place. Thus the conidia, formed on *Bromus hordeaceus*, for instance, are unable to infect *B. sterilis*, but able to infect *B. tectorum*. The conidia of this latter plant are, however, able to infect *B. sterilis*, so that *B. tectorum* occupies a middle position between *B. hordeaceus* and *B. sterilis*. We are at present quite unable to explain this curious behaviour of the conidia of what is, morphologically at least, the same species, and are compelled to assume the existence of a number of "biologic forms," adapted to special host-plants, within the limits of each species.

It appears that the ascospores show the same adaptations as the conidia with regard to their restriction to certain host-plants, although it has not yet been definitely determined whether the conidia and ascospores agree in their power of infection of certain host-plants only. The perithecia (Figs. 1 and 3), which are generally provided with a considerable number of long appendages, are formed in the autumn, but throughout the winter the asci show no trace of segmentation and are filled by granular protoplasm only; in the following spring, however, the ascospores are rapidly formed, if the necessary amount of moisture is present. The dry perithecium is generally concavo-convex in shape, but it becomes bi-convex by the absorption of moisture; this also causes the swelling up of certain mucilaginous cells in the interior of the wall of the perithecium and results in the opening of the latter by means of a horizontal slit on one side. This slit gradually extends right round the perithecium, so that its upper half becomes lifted off as a lid. At the same time the ascospores are forcibly ejected to a distance of 2 cm. or more.

It has been found that the ascospores of *Erysiphe graminis*, growing on the common barley (*Hordeum vulgare*) are unable to infect wheat, oats, rye, and other species of barley. The ascospores germinate in a very short space of time on a suitable host-plant, forming germ-tubes, which are formed at one or both ends of the spore.

Sufficient investigations have not yet been made to afford any explanation of this remarkable phenomenon of restricted parasitism. It seems quite natural to suppose, however, that the different "biologic forms" of one and the same species of mildew have become adapted to special chemical constituents in the cells of the host-plant, which they infect. And, looking at the matter from this point of view, it will be interesting to determine whether a certain biologic form is restricted to each genus or group of species of a host-plant, as seems likely, since these will most probably contain identical or almost identical chemical substances. Investigations undertaken during the last few years have shown that in the case of the rust-fungi similar "biologic forms" also occur.

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Continental Physical Notes.

BY DR. ALFRED GRADENWITZ.

The Distribution of Intensity in Line Spectra.

MANY physicists have shown, both by theoretical and experimental work, that solid bodies, like the so-called *black* body, will give off any wave lengths with increasing intensities as the temperature rises; as, however, this increase is more rapid for small wave lengths, the maximum of energy is shifted towards the latter.

It would be interesting to investigate whether the same law is true in the case of the line spectra of gases, as rendered probable by many phenomena. Very high difficulties of an experimental kind were, however, opposed to a definite solution of the problem. The luminous intensity of the lines, in fact, is by no means an adequate measure for the energy given off; such a measure being afforded only by bolometer or by thermic battery determinations. As, however, these instruments are not so far sensitive enough to allow of energies as corresponding with a spectral line of a Geissler tube being measured by their means, the only way available is to compare photometrically the intensities of the lines with those of the corresponding rays of a light source for which the distribution of the intensities is given.

This method has been used by K. Langenbach, whose researches have recently been published in the *Annalen der Physik*. The author has met with the additional difficulty, that the bands with the slightest variations in the discharge would undergo irregular broadening, altering the intensity of the emission. Although the results of the author, therefore, possess no really quantitative value, being only a first rude approximation, evidence is shown by them that in the case of discontinuous gas spectra maximum of energy is equally displaced towards smaller wave lengths as the temperature increases.

It is needless to point out the importance which an accurate knowledge as to the distribution of energy in the spectra would have to astronomers. The latter, in fact, would thus be enabled to draw accurate conclusions as to the temperature of a star from the investigation of its spectra. The attempts thus far made in this direction are not based on any sufficiently sure principles, investigations as commenced by the author being the only means of determining the temperature of a star with any degree of certainty.

On Cathode Rays Issuing from Incandescent Cathodes.

In connection with researches on the luminous phenomena shown by hot gases, E. Wiedemann had observed that strongly incandescent cathodes would give out at rather low potential differences, cathode rays of a bright blue colour; that, in other words, very hot gases exhibit a luminous emission. These singular cathode rays would in most cases be noted only on one point of a platinum or platinum-iridium wire as a thin and well-defined beam visible over distances as high as several centimetres and giving rise to a strong fluorescence wherever it struck the wall of the tube. The starting point of these rays, apparently, was not different at all from the remainder of the surface of the wire. The lower the pressure and the stronger was the intensity of the rays; as they exhibited only a slight magnetic deviability, their speed cannot be but very limited. The most remarkable feature is their strong luminous intensity, in spite of a very small cathode fall. As, however, these rays were noted only during very short intervals and on certain platinum wires, it was not possible to subject them to a thorough investigation. These researches are particularly interesting in connection with Starke's recent experiments on very rapid cathode rays, as in the present case very low rays, produced by extremely small potential differences, are being studied. In a paper recently read before the German Physical Society, the author records the following results: 1st—The magnetic deviability of the rays increases for constant temperatures of the cathode along with the pressure; this latter remaining constant, with increasing temperatures of the cathode. 2nd—These cathode rays are produced at a red heat and will cease to exist as a well-defined beam at a white heat. 3rd—As the temperature rises the cathode fall is lowered from some hundred volts down to some volts; at a fall of five volts, the author still observes a short but fairly well defined beam of rays. 4th—The ratio of the charge to the mass as determined by measurements of the cathode fall and the magnetic deviability is of the same order of magnitude as in the case of cathode rays produced by high potentials, whereas the speeds, as should be anticipated, are very small.

The presence of cathode rays at high temperatures would, according to O. W. Richardson's views, be due to the ultra-violet rays given off by the incandescent cathode, the smallness of the cathode fall having to be ascribed to the ionisation produced by the cathode rays themselves.

On the Theory of Electric Batteries.

Many attempts have been made to improve the efficiency of electric batteries, and numerous more or less lucky partial solutions of this problem have been suggested of late years. Now, in a paper recently published in *L'Eclairage Electrique*, Mr. Rosset shows that there is a practical limit to these endeavours. As, in fact, every electro-chemical couple is based on a chemical reaction, the theoretical output of the system is limited by the equilibrium constant of the latter, the system tending towards a state of well-defined chemical equilibrium instead of a total transformation. It, therefore, is illusory to hope ever to obtain the theoretical output as corresponding with Faraday's law. A further limit is opposed by the rate of reaction of the system. The author thinks lead accumulators to afford the best means of performing methodical researches in the field of storage batteries. The battery of the future, however, in Mr. Rosset's opinion, would be likely to be a primary *circulation battery*, ensuring a continuous supply of the reacting substances, the products of reaction being unceasingly carried off. The author, therefore, suggests designing what he terms *Electro-chemical Gas Burners*, transforming direct chemical energy into electric energy without the agency of any thermic motors or the present electro-chemical reservoir with their low theoretical efficiencies.

A Novel Method for Ascertaining the Molecular State of Iron and Steel Pieces.

In a recent issue of our Spanish contemporary, *La Energía Eléctrica*, A. Sandaran describes a novel method for ascertaining the physical state of axles and other iron steel pieces, this method being based on the magnetic properties of iron and its modifications. It may be inferred from the principles of magnetism that if an iron or steel piece of a machine is examined before it commences work, recording graphically the values of the magnetic induction for variable magnetising forces, an image of the magnetic properties of this piece will be obtained. Now, the axles of railway carriages and locomotives, as well as many other parts of machines, are exposed to peculiar variations in their physical state, due to the vibrations and shocks the piece undergoes during operation. These vibrations will result in a crystallic state being eventually produced, rendering the piece in question both weak and brittle. These factors at the same time diminish all the *residual* magnetic phenomena, causing the iron piece tested to assume more rapidly the average state corresponding to the magnetic force acting on it; in other words, the rising and descending branches of the magnetic curve will become little different from one another. There must, therefore, exist characteristic differences between the magnetisation curves of an axle or other iron piece as taken at different times of its service, these differences being susceptible to be determined only by experiment, observing various specimens and recording the corresponding curves, when a subsequent magnetic test of the specimen will allow of conclusions being drawn as to its actual safety.

New Applications of Alumino-Thermite with Iron and Steel.

At the recent Congress for Applied Chemistry held in Berlin, a paper was read by Dr. H. Goldschmidt on some new uses of his *thermite*. Experiments made by the author with a view to replacing the aluminium in thermite by silicon have failed to give any positive results, as the mixture once ignited does not go on burning spontaneously as is the case with alumino-thermite. The uses of thermite iron as a solder were discussed at some length, this substance allowing of uniting, not only rails and girders, but practically any kind of wrought and rolled iron at a cost much lower than by any other method. Thermite appears to be specially useful in repairing ships, some cases being recorded where ships were able to resume their route after a very short stay, whereas with any other process, repairing the broken parts would have required several weeks' rest of the steamers and necessitated very high expenses. Thermite allows of the soldering being made without any previous dismounting. If fissures are to be filled they should first be enlarged by means of mechanical tools, when the thermite iron is added. In the case of wrought iron being soldered to wrought iron, thermite iron should be used only to soften the soldering surface, hot liquid wrought iron having to be cast in afterwards so as to displace the thermite iron. Adding about 100 to 250 grams pig-iron to the thermite will result in a hard, easily forged steel with small grains, affording a convenient means of casting repair parts. (An article on the uses and properties of thermite has appeared in the February number of the ILLUSTRATED SCIENTIFIC NEWS.)

Becquerel Rays and Water.

In a paper recently read before the German Physical Society, Mr. F. Kohlrausch resumes some interesting observations relative to the influence exerted by Becquerel rays on water. Having passed the rays given off from a mixture of radium and barium bromides through an aluminium plate, 0·1 mm. in thickness, and a layer of water of about 18 mm., the author failed to state any immediate effect of the radiation. Under the influence, however, of a prolonged radiation, Mr. Kohlrausch noticed a considerable acceleration in the increase of the electrical conductivity.

As regards the interpretation of the above phenomenon, the author is not able to decide between two hypotheses, viz., that of a direct development of ions in the water and that of an accelerated disaggregation of the walls of the glass tube. As to a third equally admissible hypothesis, *i.e.*, that the surrounding air should have absorbed some substance, such as, for instance, bromine, introduced beside the stopper, the author does not think it to be true, as a special experiment made with a view to confirm it has given negative results. With this experiment an air current having passed through the radio-active substance was led through water provided with electrodes.

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Self-Electrification of Radium.

Quantitative measurements of radium rays, as so far carried out, have only been made with a view to studying the electrostatic and magnetic deviations so as to determine the velocity of the charges emitted and the ratio of the charge of one particle to the mass of the same. Now, as the positive particles discovered by Mr. Rutherford are absorbed to a much more appreciable degree than negative particles, a reservoir permeable to negative particles should take a positive charge in virtue of the positive particles it retains, the magnitude of this charge depending on the radiation emitted and being a measure of the latter. In order to base on this fact a quantitative measuring method for radium radiations, W. Wien (Physikalische Zeitschrift No. 23 p. 624, 1903), has undertaken to investigate the self-electrification of radium. In order to obtain an adequate insulation of the radium submitted to the experiments, the author introduced 4 mm. of radium bromide into a small platinum crucible, suspended by well insulated glass wire. The radium bromide could emit its radiation towards the open side of the crucible, the walls of which, on the contrary, would retain the radiation. In virtue of the strong absorption, as shown in platinum, it was to be anticipated that both negative and positive rays should be stopped on their way. In the case of equal amounts of both classes of rays being emitted, no electrification of the crucible would take place. If, however, a selective emission in favour of either takes place, one of the electricities must be absorbed because of the radiation through the opening of the crucible. The difficulty met with in the realisation of these experiments was the continual diminution in the insulating qualities of the vacuum as produced by the emanation. Radium bromide, in fact, develops a strongly conductive gas. The author has not been able to complete the development of this gas, even by maintaining radium bromide previously heated, during six weeks in a vacuum, as perfect as possible.

Although the vacuum had been driven to the highest degree accessible to experiments, the most sensitive electrometer used by the author has not detected the least trace of electrification, even in the case of the vacuum being maintained for hours. This negative result could be due to two causes: on one side, this could, in fact, be a proof of the non-existence of the phenomena anticipated, whereas, on the other hand, the emanation could still be too strong, imparting to the vacuum a too considerable conductivity. In order, therefore, to make any more accurate measurements, this emanation had to be perfectly eliminated. To this effect the author drew out a thin glass tube until its walls had a thickness of only some tenths of a millimetre; into this tube a platinum wire was sealed. The internal wall of the tube was, moreover, covered with aluminium foil touching the platinum wire. After introducing the radium bromide the tube was closed by sealing. Any electricity accumulated should then issue from the tube by passing through the platinum wire. The glass tube was suspended by similar glass wire, and introduced into the tube. As the small internal glass tube ensured an air-tight closing, no emanation could get out of it and deteriorate the vacuum. By this means the author has been able to state electric effects in very satisfactory accord with those anticipated by theory. From these researches it results that there is no possibility of determining the masses carried by the radiation by weighing, whereas the energy of the latter is by no means negligible. Apart from alterations in the mass, as produced by variations in the velocity, this energy, as calculated by the author, is 8.7 Erg. per second for negative particles and 60 Erg. in the case of positive particles.

Birkeland's Electro-magnetic Gun

The principle underlying Professor Birkeland's electro-magnetic gun consists in attracting an iron core into the interior of a solenoid and in projecting it out of the tube on the opposite side. This principle was by no means original, and the most important feature with the invention of the Norwegian Professor is the means by which satisfactory results are ensured with a comparatively low consumption of energy and practically without any sparking.

If a projectile be sucked by an electro-magnetic force into the interior of a spiral, the projectile, having become magnetic, is stopped at the centre of the solenoid, where the opposite forces acting on it are outbalanced. Interrupting the current at this very moment, the core will go on in its run and be projected out of the gun with a very considerable force, if the intensity of the current is sufficient. The difficulty that has to be overcome is the means of interrupting the current without any sparking being produced.

Professor Birkeland's gun is made up of a set of short and flat elementary coils where the current is successively interrupted as the front pole of the projectile passes through the coil. The latter will hence never exert any appreciable influence on the back pole of the projectile. This arrangement is shown in Fig. 1, where *a* is the projectile having just begun its run; *b*, the copper or bronze tube surrounded by solenoids, *c*, connected by pairs in series. The connections are formed by cut-offs, *e*, arranged along a longitudinal slot made in the gun. The arms of this cut-off may be shifted with respect to one another, so as to destroy their contact and to interrupt the current traversing the group of solenoids concerned. This movement is produced by means of a wedge-shaped cam, *f*, supported by an insulated slider, *g*, guided by a groove provided in the interior of the gun, being carried along by the projectile, as a point, *i*, of the slider is thrown into an angular groove, *k*, of the projectile. As the latter advances in its run the contact arms are successively struck and thrown aside by the cam.

In order to saturate with magnetism, the projectile, being of iron, a coil, *f* with independent source of current is used; a special motor, the axle of which is fixed to the back part of the projectile,

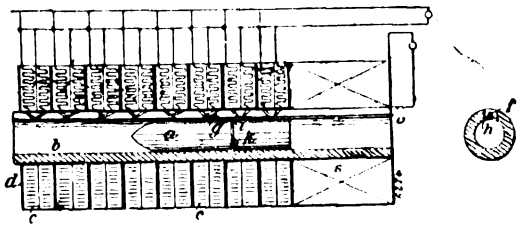


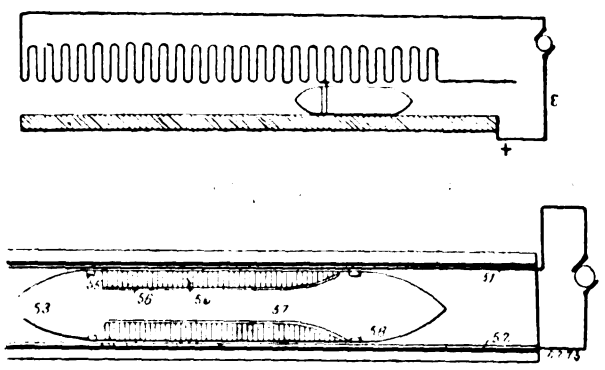
Fig. 1.

serves to rotate the latter before its longitudinal run is commenced.

The experiments made by Birkeland have given very interesting results; the extremely high overloads to which the conductors may be subjected, provided this be done only for very short periods, are particularly noteworthy; a characteristic feature of the gun in question is the production of very high overloads for only some hundredths of a second. After having been thrown into all the coils, the current is emitted from an ever-increasing number of the latter, this arrangement being shown in Fig. 1. In virtue, however, of the considerable heating effect and of the very slight attraction as exerted on the projectile, while at the opposite end of the gun, by the coils in the neighbourhood of the mouth, Birkeland prefers inserting for a beginning only the first third part of the gun into the electric circuit; as soon as a bullet is started, the second, and as the projectile has got a little farther on, the last third of the gun are switched in, allowance being made for the time necessary to impart to the current its normal value, *i.e.*, about two one-hundredths of a second. The appliances designed to close the current as the bullet advances have frequently been modified.

As regards the means of preventing sparking, the inventor utilises an interesting property exhibited by the electro-magnetic gun. When traversing the gun the magnetism of the projectile gives rise in the gun to an electro-motive force opposed to the applied tension being highest at the mouth. As, however, the time during which it acts is so short, this force will be capable of annihilating sparking at the moment of the interruption at the fore as well as at the back end of the gun. Experiment has shown, in fact, that if the interruption occurs without any sparking in any one of the coils, no sparks will be noted on the remaining coil In order to obtain this result, the projectile should, however, be of a relatively big calibre.

Birkeland has equally designed a solenoid projectile of a more reduced calibre (as high as 15 cm.), the use of which is particularly suitable when the internal resistance of the source is low. In this case the solenoids are advantageously arranged in groups connected in series, each group constituting an uninterrupted wire over which



Figs. 2 and 3

the projectile slides. The front of this wire is connected to one of the terminals of the circuit, the other end being insulated; the other terminal of the circuit being in connection with the tube of the gun, the projectile connects with one another both parts of the circuit. Fig. 3 is a schematical representation of such a gun with one continuous winding.

The solenoid projectile is made up of coils traversed by an electric current as the projectile moves, this modification being susceptible of giving much higher efficiencies as the motive force may increase up to values 16 times greater than that of iron projectiles. Contact rods arranged within the gun serve to lead the current to the solenoid of the projectile, being represented with all the necessary connections in Fig. 3; the interruption is produced as in the above attachment.

Fifty is the tube of the gun, 51, 52, contact rods well insulated and running along the whole of the gun. The projectile, 53, may be made of steel and be hollow so as to receive explosive matters. The middle portion of the projectile is surrounded by solenoids, 54, as a rule short and connected in series. The current passes from the conductor, 51, through the ring, 55, on to the conductor, 56, whence it goes through the solenoids to the conductor, 57, and thence through the ring, 58, to the conductor, 52.

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Wind-Driven Electricity Works.

The problem of using wind-power in connection with electricity works has often been investigated, the principal drawback being the variable strength of the wind, resulting in corresponding variations in the speed of the dynamo. This difficulty, however, it appears, has recently been solved by Professor La Cour, who, on behalf of the Danish Government, has, for some years past, been engaged in studying the question. In order to impart to the motor an approximately continuous speed, independently of the strength of the wind, Professor La Cour, as pointed out in a lecture delivered before the recent Copenhagen Technical and Sanitary Congress, uses an intermediate shaft placed in connection with a balance. The belt from the mill is led vertically on the disc of this shaft, its pressure on the latter being regulated by the balance bearing convenient counter-weights. This arrangement results in the belt sliding on the disc as soon as the load exceeds a given maximum. A plant of this kind, feeding about 450 glow lamps, has for nearly a year been in operation at Askov, Denmark, petroleum motors serving as a reserve in case of several days' calm weather.

The constant normal current with this works is 50 amps., and the distribution tension 2 × 110 volts. This plant has so far worked with satisfactory results and required no supervision worth speaking of. As regards the economical side of the question, a similar plant has been found to pay very well, the first cost being about £800, out of which £150 corresponds to the petroleum motor. The current is supplied to consumers at the same price as in Copenhagen, *i.e.*, at the rate of 6½d. per kw. hour for lighting and 2d. for power purposes. The receipts for energy sold have been about £140 and the expenses about £40 per year. There will thus remain £100 for the amortization of this plant, a sum more than sufficient for a capital of £800. The price of the energy could, therefore, be further lowered. In the case of very small electricity works, intended for the use of a limited number of houses, the petroleum motor may advantageously be replaced by a horse-driven contrivance. Moreover, in the case of the proprietor of the works being his own consumer, the consumption of current may be regulated according to the actual supply of wind, the cost of the plant thus being further diminished.

A solution of the problem in issue will doubtless lead towards rendering electricity accessible at relatively low cost, even in small communities, and more especially in rural districts.

The Natural History of British Wild Plants.

By J. C. Shenstone, F.L.S.

II.

As a river approaches the sea, it often deposits sedimentary matter. This accumulates and obstructs the stream, dividing it into branches, and sub-dividing it into smaller branches, forming what is known as a Delta. The river in consequence enters the sea through a number of different channels. Some of these channels would naturally allow a larger volume of water to pass than others. In some cases the sedimentary deposit would accumulate sufficiently to lie high and dry above the streams; in others it would be more or less submerged, or scarcely above the water level, when the edges of the channel would be less defined.

The divisions and sub-divisions of organic life may be compared with those of a delta. First we have the two great divisions known as the animal and vegetable worlds. In the earlier and more primitive forms of life the division separating these is by no means well defined, just as a river when it first branches might tend to wash away its banks, the streams becoming more distinct as they flowed on. The vegetable world is sub-divided into classes and sub-classes, and the sub-classes into natural orders. The orders, like the branches of the river, vary much in size, some containing very many species, others including few species. The Buttercup or Crowfoot order, described in my last article, contained very many species, but the orders we have now to write about are small orders, which in the natural system of plants stand between the Crowfoot order, the Cress or Crucifer order, and the next large group of plants.

The explanation adopted by naturalists of this sub-division of plants is that the more highly organised species have been gradually evolved from the more primitive forms of life, their efforts to adapt themselves to the varying circumstances of their environment being a great element in this evolutionary process. In some cases the conditions of life surrounding the species would remain constant for long periods, in which case the characters of the species would become well defined and constant. But in other cases the conditions of life would be much less constant, when the species would endeavour to adapt itself to the changing conditions, and its characters would consequently be less defined; thus the water crowfoots, already described, would have to adapt themselves, sometimes to flowing streams, at other times to still ponds, sometimes to deep water, at other times to shallow water, and at times even to pools which have become almost dry by summer heat. What wonder, therefore, that the individuals of this group of plants should not be at all well defined, and should give botanists much trouble to classify?

The first small family after the Crowfoot family is the

Barberry Family (*Berberideæ*),

the only British representative of which is the

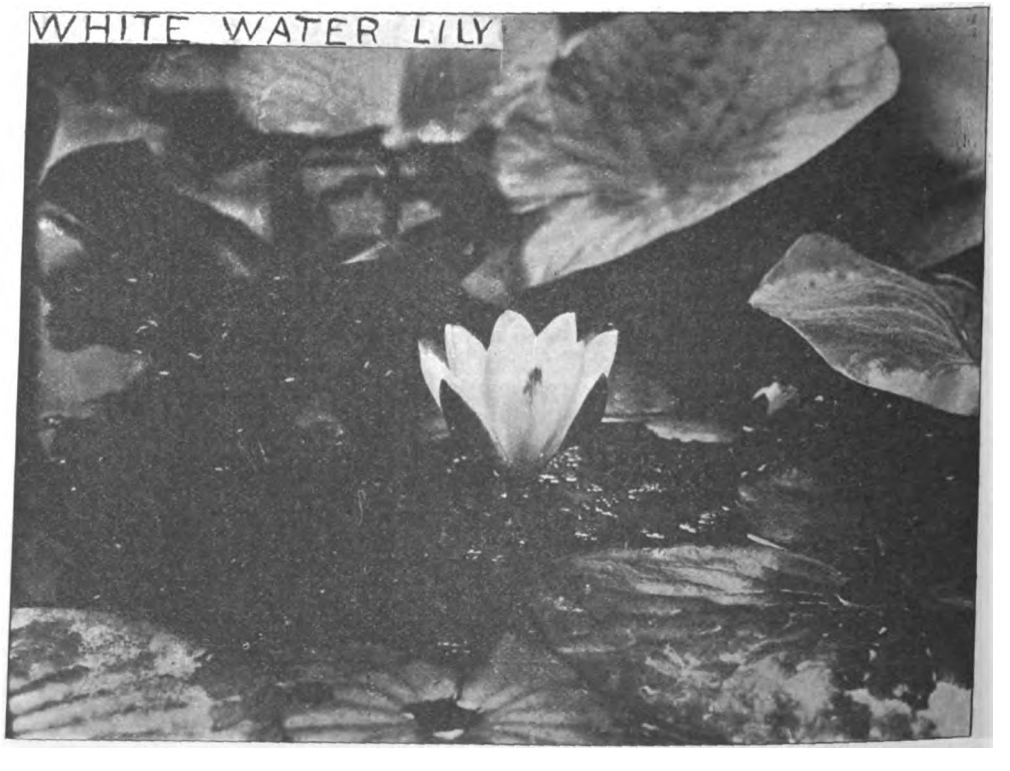
Common Barberry (*Berberis vulgaris, Lin.*),

too well known to need description. This plant is attacked by a fungus known as the Barberry Blight (*Puccinia graminis*). This disease gave rise to much controversy, from the middle of the 18th century until towards the end of the 19th century, between scientific men on the one side and practical farmers on the other. The practical farmers had, during several generations, noticed that fields of wheat near which barberry bushes grew were particularly liable to a disease known as rust, and that those parts of the fields suffered most over which wind blew which had first passed over the barberry bushes. Hence they contended that the barberry bushes were in some way the cause of the rust in wheat.

As, however, no disease at all similar to the wheat rust either in appearance or in its life history could be detected on the Barberry bushes, this contention on the part of the farmers appeared to the scientific men quite groundless.

So strongly, however, did the farmers adhere to their opinion that Barberry bushes were everywhere destroyed in corn countries, and in Massachusetts a law was passed, in 1760, to secure the complete destruction of the Barberry. The debate continued for a century after this, when, in 1864 and in 1865, De Bary settled the dispute by actually producing blight upon Barberry from the spores of wheat rust, and showed conclusively that these apparently different fungi were in reality different stages of growth, or different forms of the same species. Scientific men thus received a lesson that they must not be too ready to discredit the observations of practical men. It has since been discovered that many of the fungi which attack plants go through several different stages of growth, and that these stages, more often than not, appear upon different host plants.

The inner sepals and petals of this flower are very brilliant in colour, thus attracting insects. They are curved inwards at their points, effectually protecting the essential organs from rain. Honey is secreted by two saffron coloured bodies near the base of the petals. The petals embrace the stamens closely until disturbed, and the stalks of the stamens (filaments) are swollen at their bases and touch one another. When an insect thrusts its proboscis into a flower in search of nectar, it touches the swollen bases of the stamens, and causes them to spring forward and touch the insect, and dust it with pollen. The insect then flies off, carrying the pollen to another flower. Linnæus noticed that the anthers when touched sprung



forward and struck the insects, but did not know the purpose served by this mechanism.

The Water Lily Group (*Nymphæaceæ*)

is the next small group of British plants. The

White Water Lily (*Nymphæa alba, Lin.*)

is the most beautiful of British wild plants, and as remains of it

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have been found in interglacial deposits we may claim it as a native. This beautiful plant would, I fear, have small chance of continuing to claim a place amongst our wild flowers were it not placed out of easy reach of the human race by the fact that it usually floats on the surface of comparatively deep water.

The flower of this plant is interesting as affording us some insight into the manner in which the organs of flowers may have originated. In the centre of the flower we have the pistil, surrounded by whorls of stamens of the ordinary form, that is with rounded stalks or filaments, bearing long-shaped anthers full of pollen. But as we move outwards the filaments or anther stalks become broader and flatter, whilst the anthers become less perfect, until they appear like petals with an aborted anther stuck upon the top, and finally we come to true petals. These pass into the sepals. Some botanists tell us that the pistil and stamens were developed from the petals. Others however urge that as the pistil and stamens are the essential organs of a flower, the flower could not have existed without them and argue that the flower must have commenced with the essential organs, the floral envelopes being produced by a retrogade process from these. All agree however that there is a homology between the floral organs and foliage leaves, which explains the fact that the organs of a flower are apt to degenerate into ordinary foliage leaves.

Nearly one-third of the ash of the Water Lily plant is composed of salt, although the water it floats in and the mud it roots in may contain less salt than river water. This affords us an illustration of the fact that plants are able to abstract from the water or soil the substances which they require.

The following analyses of the ash of fresh water plants are from Kerner's Natural History of Plants, and illustrates the power plants have of extracting the materials they need for their growth.

	Water Soldier.	Water Lily.	Stonewort.	Reed.
Potash	30·82	14·4	0·2	8·6
Soda	2·7	29·66	0·1	0·4
Lime	10·7	18·9	54·8	5·9
Silicic Acid	1·8	0·5	0·3	71·5

The Water Lily is not a true water plant; it roots in the ground, and in the absence of water develops the characters of a land plant, the petioles or leafstalks become shorter and develop a strong layer of bast tissue, giving them the necessary stiffness. As with most floating leaves the upper surface of the leaves is rendered repellent to water by waxy deposits, which prevents the choking of the breathing pores.

The Poppy Family (*Papaveraceæ*)

is the next small group of British plants, of which

The Scarlet Poppy (*Papaver Rhœas Lin.*)

is the most familiar species. It appears to have been Ruskin's favourite plant. He says of it: "In our English prayer book translation, the first verse of the ninety-third Psalm runs thus: 'The Lord is King; and hath put on glorious apparel.' And although, in the future republican world, there are to be no Lords, no Kings, and no glorious apparel, it will be found convenient, for botanical purposes, to remember what such things once were, for when I said of the Poppy, in the last chapter, that it was 'robed in the purple of the Cæsars,' the words gave, to anyone who had a clear idea of a Cæsar, and of his dress, a better, and even a stricter, account of the flower than if I had only said, with Mr. Sowerby, 'Petals bright scarlet,' which might just as well have been said of a pimpernel or scarlet geranium—but of neither of these latter should I have said 'Robed in the purple of the Cæsars.' What I meant was, first that the poppy leaf looks dyed through and through, like glass, or Tyrian tissue, and not merely painted; secondly, that the splendour of it is proud—almost insolently so. Augustus in his Glory might have been clothed like one of these, and Saul; but not David, nor Solomon, still less the teacher of Solomon when He puts on 'glorious apparel.'" The poppies are all more or less narcotic even when grown in colder climates. Opium is produced in hot climates by making incisions in the green capsules of the opium poppy, and allowing the milky juice which exudes to coagulate; this is the opium of commerce. Shakespear says:

> Not Poppy nor Mandragora,
> Not all the drowsy syrups of the world
> Shall ever medicine thee to that sweet sleep
> Which thou ownedst yesterday—
>
> *Othello* III, 3, 330

Though not so poisonous as the opium poppy, the scarlet poppy is decidedly narcotic and unwholesome. If the juice of the poppy be put into some solution of sugar of suitable strength, and left for some days, the sugar will disappear, even if other ferments be kept from it.

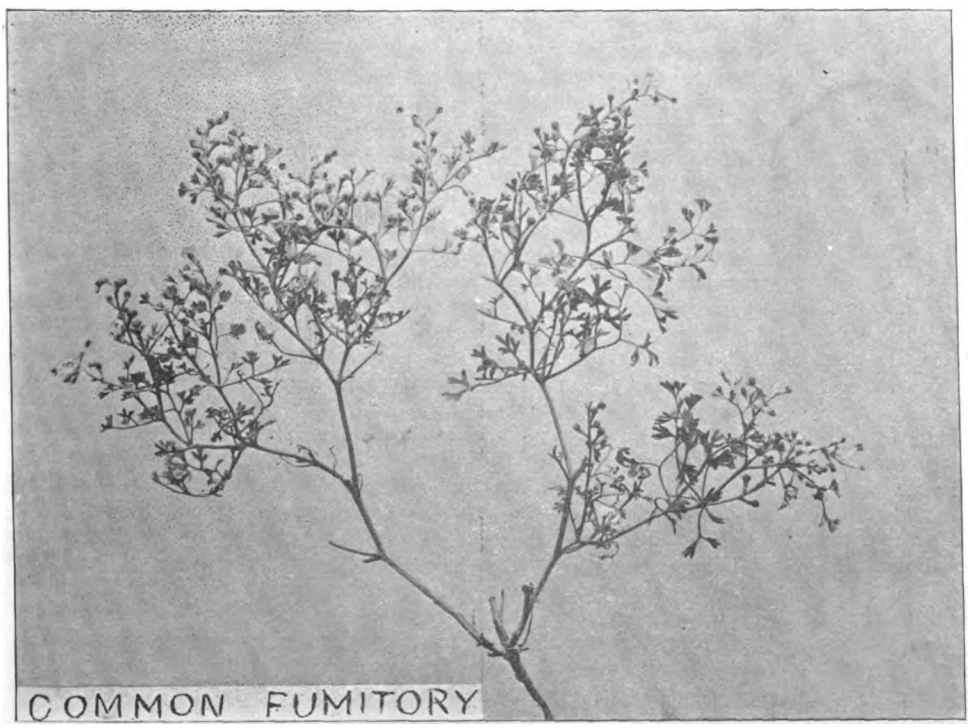
The upper part of the seed capsule of the poppy contains a series of little doors through which, when the plant is swaying in the wind, the seeds come one by one. The little doors are protected from rain by overhanging eaves, and are even said to shut themselves in wet weather. There are several species of poppy included in our flora: the

YELLOW HORNED POPPY

Horned Poppy (*Glaucium luteumscop*)

also belongs to this group. It is a stout plant having the peculiar blue green colour known to botanists as glaucus. The plant is remarkable for the strange development of its capsules. These are often as much as a foot long, and shaped like "horns," and give the plant a peculiar appearance as it grows by itself upon shingly soils by the sea. Ben Jonson alludes to it in his witch's song:

> Yes, I have bought to help my vows,
> Horned Poppy, Cypress boughs,
> The Fig-tree wild that grows on tombs,
> And juice that from the larch-tree comes.



COMMON FUMITORY

Darwin made a long series of experiments upon the movements of this plant. The same revolving motion which, when more developed, enables climbing plants to grasp any object at all within reach for support, may be observed in this and most other plants, the stems moving in such a manner that they describe elliptical or oval figures. Darwin found that every part of this plant circumnutated.

The fluid contents of the hairs of the horned poppy, when examined under the microscope, will be seen constantly in circulation. The particles of protoplasm form themselves into streams, which coalesce into a network, the reticulations of which change their positions.

The Common Celandine (*Chelidoneum majus, Lin.*) also belongs to the poppy group, and is called Devil's milk, Felon wort, Kill wort, Swallow wort, Tetter wort, and Wart flower.

It contains a rich yellow milk which exudes from its milk vessels when its stem is broken. Pliny, described by Mr. Darwin as "that awful repository of all the errors of antiquity," tells us that the plan was discovered by swallows, who anointed their young with its juice.

It is a violent, acrid, and irritant poison, and its yellow juice, as implied by its various names, was a popular remedy for warts. Kerner found that ruminants would rather go without food than eat this plant.

The seeds of this plant are often carried into their nests by ants. In the botanic garden at Vienna the presence of seeds of the common Celandine is a constant feature in ants' nests, and Kerner suggests

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that the ants found an easily accessible supply of food, and also distributed the seeds of the plant.

Buds are occasionally formed upon the leaves of this plant.

The Fumitory Family (*Fumariacea*)

is the next small group, and the

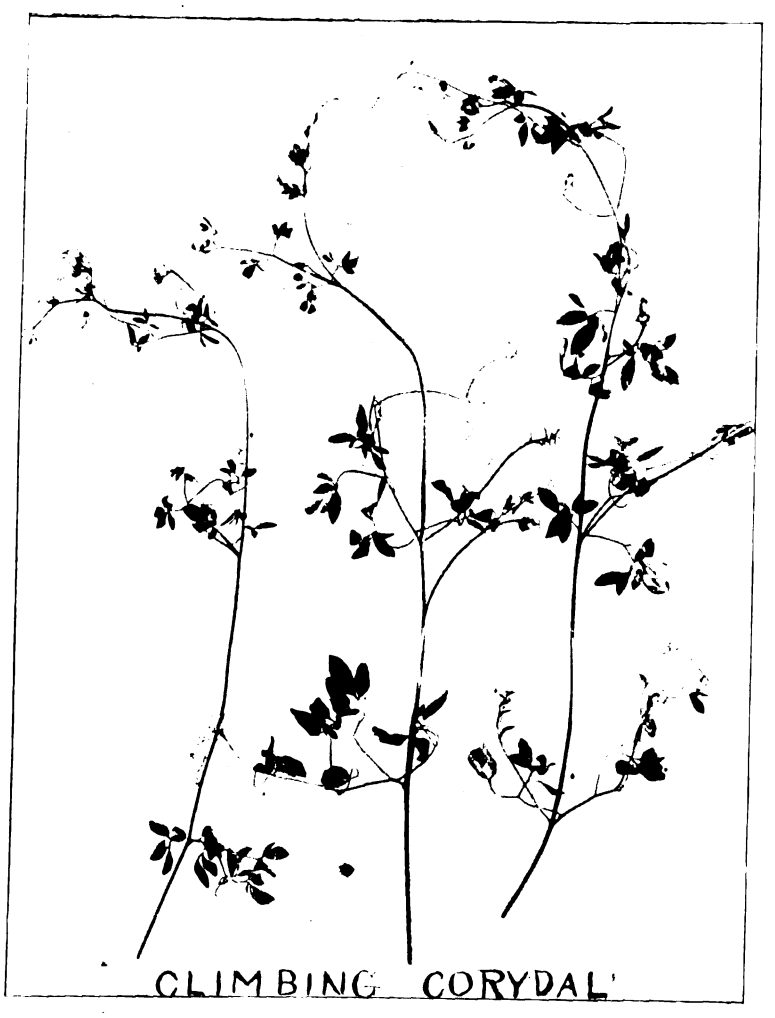
Common Fumitory (*Fumaria officinalis, Lin.*)

is its most typical species. It was called Earth Smoke, or Fume of the Earth. Its name was originally derived from the fact that when applied to the eyes it makes them smart, as smoke does; but a legend grew up from the name, that it sprang up from the ground from smoke without seed. We are told in the "Grete Herball" that it is called fume or smoke of the earth because "it is ingendred of a cours fumositie rysing from the earthe, wyndeth and wryeth out, and by working of the ayre and sunne it tourneth in too thys herb." The same tale also appears in "Ortus Sanitatis."

Shakespear speaks of Fumitory as a sign of neglected soil.

Her fallow leas
The darnel, hemlock, and rank fumitory
Doth root upon while that the coulter rest,
That should deraginate the savagery
The even mead that erst brought sweetly forth
The freckled cowslip, burnet, and green clover,
Wanting the scythe, all uncorrupted rank.

The flower is very highly specialised by insects. Honey is secured from a short process developed from the upper stamens, and lodged in a pouch. A bee, to reach it, must lodge on the lower petals or hood, and would rub the under surface of its body against the stigma, which, however, is already covered by pollen, and would when not visited by bees fertilise itself. It is not much visited by insects, its flowers being small, and opening at a time when so many plants yield honey.



A most graceful little British plant belonging to this small group is the

Climbing Corydal (*Corydalis claviculata, DC.*),

or "Holewort," so called from its hollow root. It is peculiarly delicate and graceful, and is interesting as standing midway between those plants which climb by their leaves and those which have tendrils formed for the purpose. Darwin studied its mode of climbing most minutely. A large number of its tendrils still bear leaflets, but excessively reduced in size; some few have become fully-developed tendrils and are destitute of leaves. On quite young plants the leaves are not modified in any way, but on full-grown plants all the leaves have their extremities converted into more or less perfect tendrils, thus affording us an instance of the evolution of a tendril. The tendrils are so sensitive that a weight of only 1-10th of a grain caused them to be greatly curved in less than four hours, and when the weight was removed they straightened themselves in about the same time. The leaf is in continual movement, describing large and irregular ellipses, so that a considerable space was swept in search of support. If it failed, it soon lost its irritability and power of movement.

Its flower, which is similar in shape to the fumitory, and specialised, has not been much studied as regards its fertilisation.

The Radium Theories.

Next to its importance as an organised demonstration on behalf of scientific education the British Association of 1903 may be memorable on account of the opportunities it afforded the physicists and the chemists of discussing the properties of radium. There are three theories of the chief phenomena of radium: the Rutherford theory, the slightly diverse Crookes theory, and the opposed theory of some chemists. The phenomena which are the subject of theory are also three in number. The first of them is the power radium possesses of emitting rays of various kinds, rays which exert a pronounced effect on other substances. The second is the emanation from radium of a gas which can be collected and can be condensed at a temperature about 130 degrees below zero. The third phenomenon is that radium is continually giving out heat, and when enclosed can maintain itself at a temperature higher than that of the surrounding atmosphere. It is with regard to the last phenomenon that the most important pronouncements of the conference of the Physical and Chemical Sections were made. Professor Rutherford has imagined that inside the atom of radium the inconceivably small entities which are called electrons, and which we may imagine as continually travelling at enormous speeds, are constantly jostling one another and form dynamic systems of unstable equilibrium. What would be the consequences? In the first place, the internal jostlings would produce heat—the mysterious heat which radium is always giving out. In the second place, these little systems within the atom tend, by collision, to break up. In that eventuality part of the members of the system fly out and away. These are the rays of various kinds which come from the radium. They may also be the gas which emanates from the radium. The remaining members of the system form into a new system, also unstable, and continue the processes and phenomena of radium. This fascinating theory has commended itself to many physicists. It has not found acceptance among some chemists. Professor Armstrong, for instance, pointed out that there is no positive evidence in terrestrial nature of any such dissociation. Mr. Ackroyd has gone so far as to attribute the phenomena to surface decrepitation of the radium salt. These are the dissentients who think that radio-activity is not to be attributed to the internal energy of the atom at all. Sir William Crookes and Professor Johnstone Stoney, while giving a cautious approval to the internal energy theory of radium, have tentatively propounded an alternative theory of the way in which it continually gives out heat. It may, they think, have the power of extracting energy from the movement of the molecules of the air which impinge on its surface, or, indeed, from the moving molecules of whatever body it may be in contact with. This theory lacks the ingenuity of the other, but it appears from the Southport discussion to resemble more nearly the explanation which has the approval of Lord Kelvin, though Lord Kelvin does not postulate the movements of molecules, but the movements of the ether on the supply of energy. The discussion on September 10th may be said to have begun with Professor C. Vernon Boys' presidential address, from which the following is an extract.

Professor C. V. Boys' Summary.

"Thanks to the industry and genuis of J. J. Thomson, Rutherford and Soddy, Sir William and Lady Huggins, Dewar and Ramsay, and others in this country, besides Professor and Madame Curie and a host of others abroad, this mystery is being attacked, and theories are being invented to account for the marvellous results of observation; but the theories themselves would a few years ago have seemed more wonderful and incredible than the facts, as we believe them to be, do to-day. An atom of radium can constantly produce an emanation, that is something like a gas, which escapes and carries with it wonderful properties; but the atom, the thing which cannot be divided, remains, and retains its weight. The emanation is truly wonderful. It is self-luminous, it is condensed by extreme cold and vapourises again: it can be watched as it oozes through stopcocks or hurries through tubes, but in amount it is so small that it has not yet been weighed. Sir William Ramsay has treated it with a chemical cruelty that would well-nigh have annihilated the most refractory or permanent known element; but this evanescent emanation comes out of the ordeal undimmed and undiminished.

Not content with manufacturing so remarkable a substance, the radium atom sends out three kinds of rays, one kind being much the same as Rontgen rays, but wholly different in ionising power, according to the experiments of Strutt. Each of these consists of particles which are shot out, but they have different penetrative power: they are differently deflected by magnets and also by electricity, and the quantity of electricity in relation to the weight is different, and yet the atom, the same atom, remains unchanged and unchangeable. Not only this, but radium or its emanations or its rays must gradually create other bodies different from radium, and thus, so we are told, one at least of those new gases which but yesterday were discovered has its origin.

Then, again, just as these gases have no chemical properties, so the radium which produces them in some respects behaves in a manner contrary to that of all proper chemicals. It does not lose its power of creating heat even at the extreme cold of liquid air, while at the greater degree of cold of liquid hydrogen its activity is found by Professor Dewar to be actually greater.

Unlike old-fashioned chemicals which, when they are formed, have

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all their properties properly developed, radium and its salts take a month before they have acquired their full power (so Dewar tells us), and then, for anything we know to the contrary, proceed to manufacture heat, emanations, three kinds of rays, electricity, and gases for ever. For ever; well, perhaps not for ever, but for so long a time that the loss of weight in a year calculated, I suppose, rather than observed, is next to nothing. Professor Rutherford believes that thorium or uranium, which act in the same kind of way, but with far less vigour, would last a million years before there was nothing left, or at least before they were worn out; while the radium, preferring a short life and a merry one, could not expect to exist for more than a few thousand years.

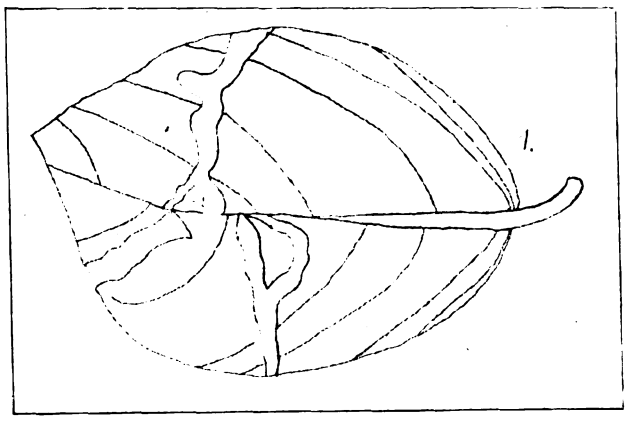
In this time one gramme of radium would evolve one thousand million heat units, sufficient, if converted into work, to raise five hundred tons a mile high; whereas a gramme of hydrogen, our best fuel, burned in oxygen, only yields thirty-four thousand heat-units, or one thirty-thousandth part of the output of radium. I believe that this is no exaggeration of what we are told and of what is believed to be experimentally proved with regard to radium; but if the half of it is true the term "the mystery of radium" is inadequate; the miracle of radium is the only expression that can be employed."

Lord Kelvin's Criticisms.

Lord Kelvin drew attention to the fact, now known as a result of observation and experiment, that radium had been found to emit three types of rays—(1) the α rays, positively electrified and largely stopped by solid, liquid, or gaseous screens; (2) β rays, more penetrative than α and negatively electrified; (3) γ rays, electrically neutral and much more penetrative than either of the other two, passing with but little loss through a lead screen 1cm. thick, which is an almost perfect screen against the other rays. A simple *prima facie* view was to regard the γ rays as merely vapour of radium; the β rays seemed certainly to be atoms of resinous electricity, electrons as he had called them. The α rays, according to his recent resuscitation of the doctrine of Æpinus, were atoms or molecules of matter, probably atoms of radium, or perhaps molecules of bromide of radium. The electro-ethereal hypothesis above referred to afforded a ready explanation of the relative penetrating power of the three radiations and of the fact that each one of them made its existence known to us by conferring electric conductivity on air or on any ordinary gas on which it was present. Taking the γ rays first, we had to explain the free penetration of unelectrified radium molecules through dense liquid or solid matter. An easy assumption sufficed. Let the Boscovitchian mutual forces—that was, the chemical affinities and the repulsions—between an atom of radium and the atoms of lead and other permeable substances be absolutely zero or small enough to allow the known permeation. Taking next the α radiation, the apparent great absorption of the vitreous electric emanation from radium was only apparent. It meant that an atom shot from radium with less than its neutralizing quantum of electrons could not go far through a solid or liquid without acquiring the neutralizing quantum. The β absorption might be regarded as probably real. Atoms of resinous electricity shot from radium could not be expected to enter a screen of metal, glass, or wood or liquid and leave at the other side, irrespectively of the insulation of the screen and of the radium. The full consideration and experimental investigation of the emission of atoms of resinous electricity from radium hermetically sealed in a glass bulb or tube led to surprising and interesting results. As to the γ rays, there was no difficulty in supposing that non-electrified vapour of radium passed very freely through glass or metals without any electric disturbance. It had been published that loss of weight in the course of a few months had been proved. Returning to Becquerel's original discovery in respect to uranium—the electric conductivity induced in air and other gases by a radio-active substance—there was a ready explanation in the resuscitation of the old doctrine mentioned. The ordinary thermal motions within any solid or liquid or gas must cause occasional shootings out of electrons from the substance, and the motion of these electrons, under the influence of electrostatic force, must contribute to the electric conductivity of the gas—must, in fact, constitute all of it which was not due to transport of atoms of the gas carrying less than the neutralizing quantum of electrons. Thus every substance must possess radio-activity. Some interesting remarks would be found in the *Philosophical Magazine*, where it was pointed out that radium was 300,000,000 times more active than the most active common material yet experimented with. How was this enormous radio-activity of radium to be accounted for? Lord Kelvin suggested that it might be because it was exceedingly polyelectronic; that the saturating quantum of electrons in an atom of radium might be hundreds or thousands or millions of times as many as those of atoms of ordinary material. But this left the mystery of radium untouched—Curie's discovery that it perpetually (?) emitted heat at a rate of about 90 Centigrade calories per gramme per hour. If emission of heat at this rate went on for little more than a year, or, say, 10,000 hours, there was as much heat as would raise the temperature of 900,000 grammes of water 1° C. It seemed to Lord Kelvin utterly impossible that this could come from a store of energy lost out of the gramme of radium in the 10,000 hours. It seemed to him, therefore, absolutely certain that if emission of heat at the rate of 90 calories per gramme per hour, found by Curie at ordinary temperatures, or even at the rate of 38, found by Dewar and Curie from a specimen of radium at the temperature of liquid oxygen, could go on for month after month, energy must somehow be supplied from without, to give the energy of the heat getting into the material of the calorimetric apparatus. It was suggested that somehow ethereal waves might supply energy to the radium while it was giving out heat to the ponderable matter around it. Think of a piece of black cloth hermetically sealed in a glass case and sunk in a glass vessel of water exposed to the sun; and think of another equal and similar glass case containing white cloth submerged in an equal and similar glass vessel of water, similarly exposed to the sun. The water in the former glass vessel would be kept very sensibly warmer than the water in the latter. This was analogous to Curie's first experiment, in which he found the temperature of a thermometer with a little tube containing radium, kept beside its bulb in a little bag of soft material, to be permanently about 2° C. higher than that of another equal and similar thermometer, similarly packed with a little glass tube not containing radium beside its bulb. By changing the water in the two glass vessels a calorimetric investigation might be made, showing how much heat was given out per hour by the black cloth to the surrounding glass and water. Here thermal energy was communicated to the black cloth by waves of sunlight, and given out as thermometric heat to the glass and water around it. Thus, through the water, there was actually energy travelling inwards, in virtue of waves of light, and outwards through the same space in virtue of thermal conduction. This suggestion respecting radium might be regarded as utterly unacceptable, but, at all events, he thought it would be conceded that experiments should be made comparing the thermal emission from radium wholly surrounded with thick lead with that found with the surroundings hitherto used.

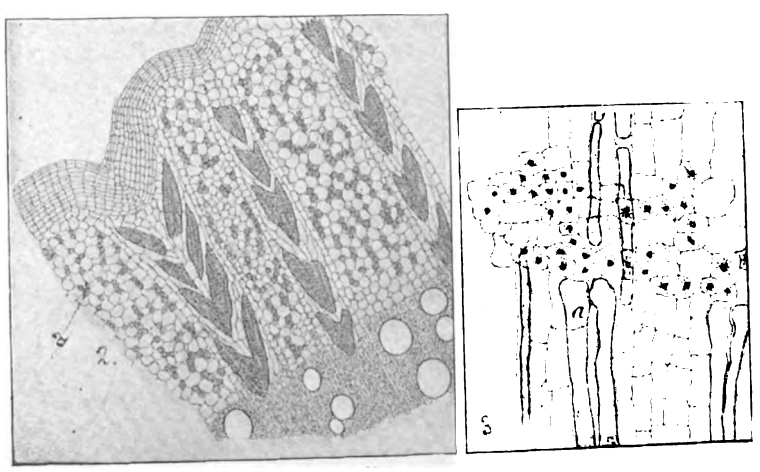
Possible New Rubber-Plants

The different kinds of caoutchouc, gutta-percha, and india-rubber, are at the present day obtained from a number of plants—*Castilloa*, *Ficus* (india-rubber-tree), *Hevea*, *Landolphia*, *Mimusops*, *Palaquium*—belonging to various orders in the natural system. These plants contain numerous elongated tubes, filled by a liquid (the latex), rich in globules



of caoutchouc or gutta-percha, which, in fact, form an emulsion in the same. Chemists are not at all agreed on the difference between caoutchouc and gutta-percha, and no precise definition of each is possible. In all the cases above mentioned the product is obtained by tapping the tree (*i.e.*, making an incision in the bark) and allowing the fluid latex to flow out; the latter soon coagulates on exposure to the air, and thus the crude caoutchouc is obtained.

During the last fifteen years quite a number of plants have, however, become known, which differ from those just mentioned in the fact that their latex is almost solid in consistency. The numerous



latex-containing tubes (termed laticiferous tubes) of these plants are occupied by solid threads of almost pure caoutchouc. These threads are highly elastic, and, as a consequence, if any part of a plant containing them is broken into two and the two pieces carefully drawn apart, large numbers of them extend across from the one half to the other (Fig. 1, showing a broken leaf of one of these plants with the threads of caoutchouc). When the number of laticiferous tubes occurring in the organ in question is considerable, the dense mass of white elastic threads connecting the broken halves is truly striking. This phenomenon has been observed in plants belonging to diverse orders, but is,

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perhaps, most abundantly represented in that order, to which our common spindle-tree belongs. In a number of these plants the caoutchouc-containing tubes are found in all the organs (Fig. 2 shows a transverse section of a branch containing such tubes, and Fig. 3 shows them in longitudinal section), whilst in others they are confined to the stem and the root; in these latter species, moreover, they only commence to make their appearance in stems of some years of age, although the roots seem to acquire them at a somewhat earlier period. The common European spindle-tree (*Euonymus europaeus*), for instance, possesses such caoutchouc-tubes in the bark of thick branches, although never in any very great numbers; the Japanese spindle-tree (*Euonymus japonicus*), however, is provided with numerous caoutchouc-containing laticiferous tubes in the bark of its thicker branches, in fact, a dense layer of them is formed annually after the stem has attained a certain thickness. In both of the species mentioned the tubes are restricted to stem and root, but in tropical (American and Asiatic) representatives of the same order, they occur throughout all parts of the plant, and in astounding numbers in the bark of thick stems. In a Chinese plant—the Tu-Chung (*Eucommia ulmoides*)—they are likewise very abundant in all the organs of the plant; this species is at the present moment being successfully cultivated at Kew and in Paris, and it seems possible to grow it in the open in the European climate.

It has already been mentioned above that in these plants the contents of the laticiferous tubes are semi-solid in their consistency, and this feature constitutes one of the drawbacks against their employment on a large scale for commercial purposes. Tapping the tree would appear to be of no use in these cases, and the only way of obtaining the caoutchouc is to remove the bark and dissolve out the product—which, in most cases, probably means killing the plant. Further, most of the species in question are very rare and little known, so that nothing can at present be said with regard to the possibilities of cultivating them in large numbers—a point, however, which encourages us to hope that further investigation may indicate a way of using them commercially and bringing about a reduction in the high price of rubber.

A Radiation Motor.

Interesting Experiment with Delicate Convection Currents.

THE following experiment illustrates in a very interesting way the absorption of heat by carbon and the motive power of extremely feeble convection currents:—

Take a piece of very light wire—No 23-gauge brass wire answers best. The length should be about six inches. Exactly in the centre, wind it once round a needle so as to form a small loop (see Fig. 1). With pliers bend the wire as shown in

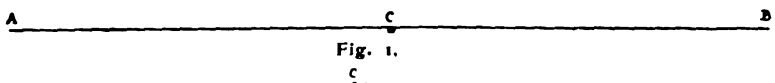

Fig. 1.

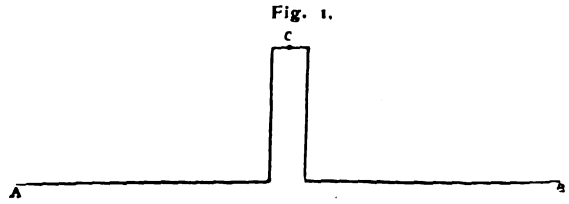

Fig. 2.

Fig. 2. Through the loop in the centre, either before or after bending, solder, point downwards, about half an inch of fine needle. On each of the two projecting ends of the bent wire, A and B, secure a piece of mica, about 3 inches by 4 inches, just thin enough not to bend by its own weight. The method of attaching the pieces of mica is shown in Fig. 3. Three holes, H, I, J, are pierced through the mica,

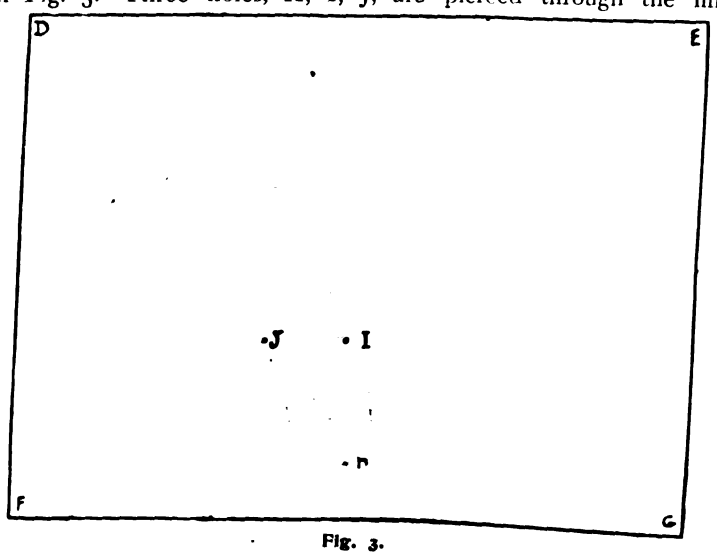

Fig. 3.

D, E, F, G, and the wire is passed through these holes and bent back so as to hold them quite firmly. Having mounted them thus, one on each of the projecting arms of the wire, these sails must be made to incline at an angle of about 45 degrees in opposite ways, so that when the wire frame is supported on the needle-point one of the sails will slope towards you and one from you. They are easily adjusted to this position by means of the pliers. The only important point that needs emphasising is that the sails must be at a lower level than the needle-point, which is to be their supporting axis. If this point is below them it will not be possible for them to balance. To support the axis, blow a glass tube so that it has a rounded or slightly bulbed end (Fig. 4),

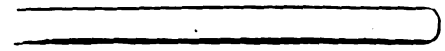

Fig. 4.

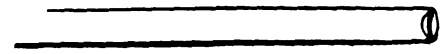

Fig. 5.

and then, heating this bulb again in the flame, draw it inwards, by drawing in air at the other end of the tube, and a smooth round cup will be formed (Fig. 5), which, when the tube is fixed upright, will form a support for the needle (see Fig. 6). The little motor should

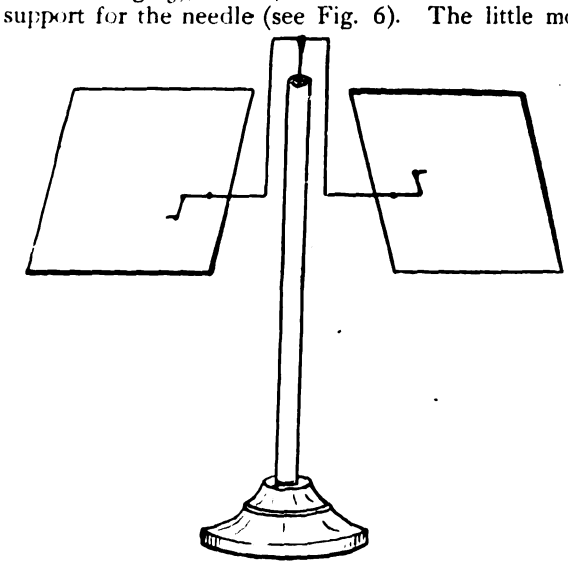

Fig. 6.

hang quite symmetrically, and if the sails do not exactly balance each other one must be slightly weighted near the edge by attaching a small narrow strip of card or some other counterbalance. Having secured a complete balance, and having fixed the tube support vertically in a small stand, the vanes must be lightly smoked on both sides in the flame of a candle. All that is now required is a glass shade to cover the little instrument and keep off all draughts and currents of air. The shade should be large enough to allow nearly an inch between the sails and the inside glass, and the height of the stand should be such that the vanes are about midway between the top and bottom of the shade.

All this being completed, place the instrument near a window in a good light, or in the open air—not necessarily in sunlight—and the vanes will promptly commence to turn round, the direction of rotation indicating an upward current of air. They will continue to turn, in fair weather and foul, on the coldest days of winter or in the hottest days of summer, from early morn to dewy eve. At dusk, or just before sunset, they will sink sleepily to rest, but they wake again with the sun, to perform their daily round once more, their behaviour being strangely suggestive of life with its alternations of work and rest, of sleeping and waking.

The instructions for making the little instrument are somewhat minute and specific, for the reason that they are based on the results of a great many trials, and any departure from them is apt to result in disappointment. If, for example, the mica is thinner than is recommended, or smaller, or if, instead of smoking it the experimenter thinks to improve upon the suggestion by painting it with lampblack, he will probably find that the sensitiveness of his instrument is not so great as he expected, and that on a dull day it refuses to work at all.

The movement is obviously due to convection currents rising from the vanes, the smoke on which absorbs the heat which is present in all light.* The support and the bottom of the glass shade may also be blackened to increase the convection. But it is astonishing how infinitesimal are these convection currents. Though the delicately poised instrument sails boldly round by their agency, they do not appear to have power to raise a mote from its resting place. The lightest dandelion-seed may be carefully placed on one of the vanes, and (if the shade can be replaced without disturbing it) it will be carried round and round for hours or days without changing its position, while, if a single thread of spider's web be attached to one corner of a vane, it will hang down like a rope, while the instrument is, nevertheless, in full movement.

The vanes may be smaller than the size mentioned, but not with equal sensitiveness, and if they are below an inch square (however thin and light), they will hardly show any movement, even in direct sunlight. The shape of the shade is immaterial, and it may be made of square panes of glass glued or pasted together at the edges with paper. It is, of course, important that the shade, whatever its form, should be fairly air-tight—at any rate, proof against outside draughts.

* Perhaps, strictly speaking, it should be said that all light may be converted into heat by the substances which absorb it.

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It need hardly be said that there is no connection in principle between this instrument and Crookes's well-known radiometer, the movements of which are not due to convection currents. With regard to the convection motor, also, there is a good deal that remains unaccounted for if it is supposed that its action is to be accounted for entirely by the simple principle of convection arising from the heating of its sails by absorbed radiations. Why, it may well be asked, should the smoked vanes remain all day at a higher temperature than the surrounding air to which they are constantly giving up their heat? Why, again, should not a reverse movement succeed at night? As good absorbers are good radiators it might be expected that instead of sinking to rest in the evening the vanes would, for a time, at least, cause a down draught in cooling, as they cause an upward current in receiving heat. This, however, is not the case, and when the day is done the motion simply ceases, without any signs of reaction.

The behaviour of the instrument under the influence of artificial illuminants is also perplexing. It will respond to the light of a candle, especially in the dusk, while yet a little daylight remains to aid the supply of heat. To an oil lamp, even of brilliant illuminating power, it is generally strangely unresponsive, and yet to the light of an incandescent electric lamp it is very sensitive, much more so than to any other illuminant, except the arc light. To incandescent gas, on the other hand, it does not respond very freely, in spite of its brilliancy.

In general, it seems to appreciate the presence of ultra violet light, and it would be interesting to know how it behaves in the shimmer of a Giessler tube, or in the new mercury light. In daylight its worst enemy is really foggy weather, when, no doubt, a good deal of the ultra violet radiation of the sun is absorbed. If it can be actually demonstrated that the ultra violet rays are operative, it opens out a new field of conjecture, for the circumstance would appear to indicate a possible property of carbon hitherto unsuspected, viz., a sort of fluorescence, feeble, no doubt, in intensity, yet extraordinary in range —degrading the ultra violet vibrations all the way down the colour scale and transforming them into the lower octave of the infra red.

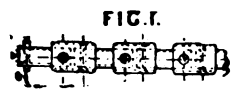
Recent Patents.

9184. Photography. CLARKE, E. R., 35, Leinster Gardens, London, W. April 21.

Relates to the tricolour process for producing photographs in natural colours. A sheet of paper or the like is mounted on a glass plate and varnished with celluloid varnish to make it impermeable to aniline dyes. It is then coated with bichromated gelatine mixed with chloral hydrate. A print is made on this film from one of the negatives, the film is developed in a solution of celluloid and dyed with the complementary colour. Other two layers are applied above the first layer and printed (from the other two negatives) developed and dyed in a similar way. Coloured standard negatives are prepared to determine the depth to which the dyeing in each operation is to be carried. The paper is stripped off the glass when the print is finished.

8574. Flexible Shafts. CLARK, W. T., PIDDUCK, E. J., and DAY, J., [*trading as* Clark, W.], 528, Oxford Street, London. April 12.

FIG.1.



The driving portion of a flexible shaft is composed of short tubes of two different diameters arranged alternately and connected together by transverse pins. The inner tubes may be replaced by solid rods.

8858. Electric igniters. HELLMANN, H. W., 7, Zinzendorfstrasse, Berlin. April 16.

FIG.1.

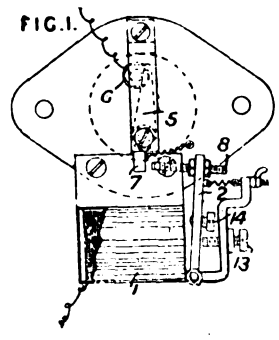
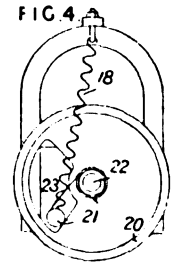


FIG.4.



The invention is mainly applicable to igniting in explosion engines. Contact is broken between the two terminals 5, 6 in the sparking-plug by an electromagnet 1, which attracts its armature 2 and causes a screw 8 on it to impinge against the rail 7 of the lever 5. The movement of the armature may be adjusted by the screws 13, 14. Its exciting current is produced by a magneto-electric machine, Fig. 4, in which the armature spindle 22 is driven by a wheel 20 with a slot 23 which engages a crank-pin 21 on the shaft, and, in pulling it round, stretches the spring 18, or lifts a weight, and suddenly releases it, causing the armature to move quickly and produce a strong current.

9815. Electric sparking, preventing. WISE, W. L., 46, Lincoln's Inn Fields, London.—(Birkeland, K., Christiania, Norway.) April 29.

FIG 2.

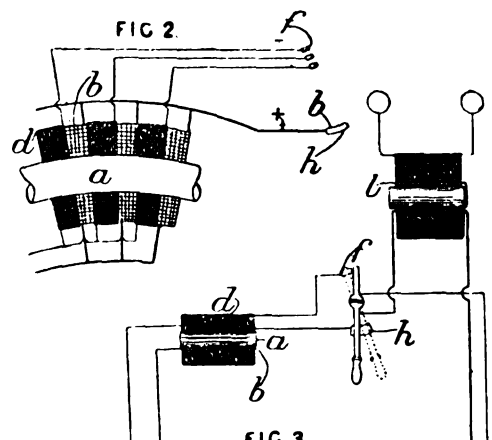
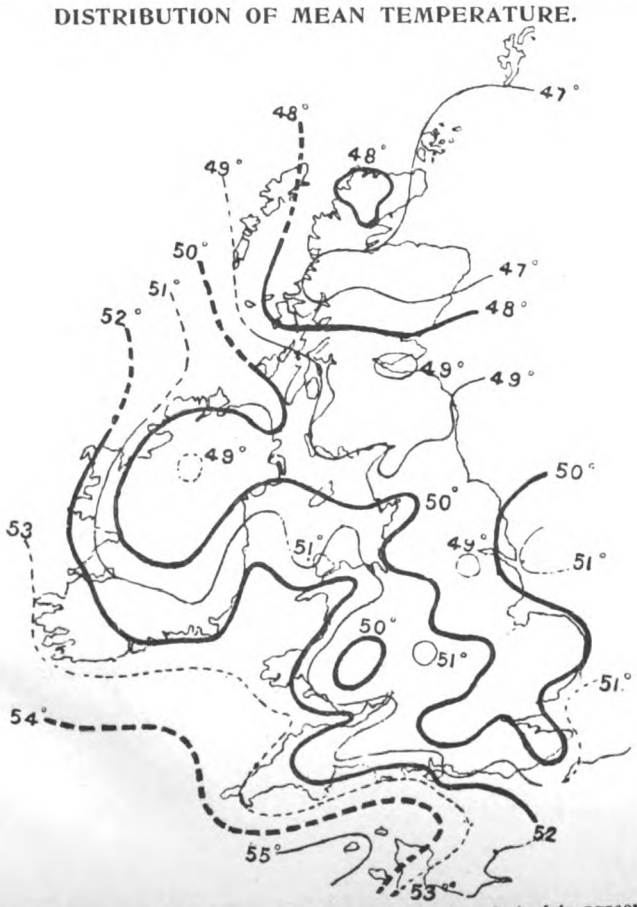


FIG.3.

Relates to the prevention of sparking in interrupting circuits, such as in wireless telegraphy, by introducing a counter-electromotive force at the moment of breaking. Fig. 3 shows one arrangement. A coil *b* in the primary of the transformer *l* is wound round a coil *a*. A second coil *d* is wound round the core, and is connected up to the circuit at the contact *f* just before the main circuit is broken at *h*. In the form shown in Fig. 2, the core *a* is annular, and the coils *d*, *b* are in sections arranged in parallel. Commutators may be provided for reversing the currents after each reversal. Reference is made to Specification No. 23,279, A.D. 1902.

LAST YEAR'S WEATHER—OCTOBER, 1902.

DISTRIBUTION OF MEAN TEMPERATURE.



The general distribution over the United Kingdom is in fair agreement with the normal. Over eastern and central Scotland and on the south-east coasts of England the mean values were slightly below the average,* but in all other localities they were above it, the excess being greatest at some stations in the south of Ireland.

RAINFALL.

Rainfall was considerably less than the average* over the United Kingdom generally, but showed an excess at a few isolated places in the north and north-west.

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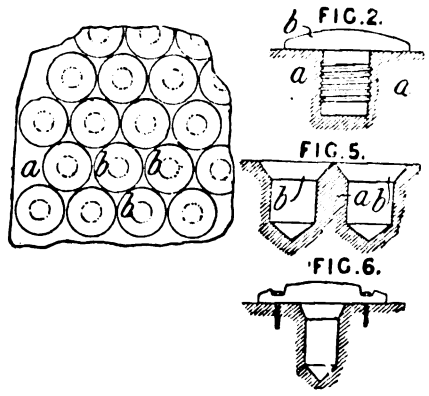
8764. Armour and armour-plating. SCHNEIDER, C. P. E., Le Creusot (Saone-et-Loire), France. April 15.



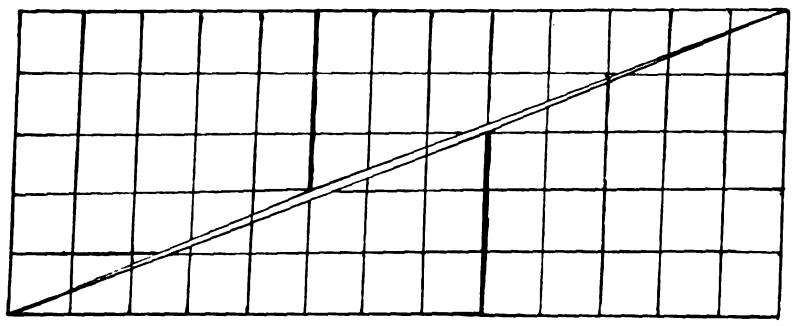
Armour and armour-plating for ships, turrets, and other structures consists of a backing *a* provided with impact discs or pieces *b* of great hardness, arranged independently of each other, and either fixed mechanically or merely forced into place, forming a sub-divided impact surface, and, with their fastening-devices, localizing the effect of the projectile and facilitating its deviation. Methods of fixing are shown in Figs. 2 and 6, and the discs *b* may be replaced either by parallelograms fixed by screws or by pins in the form of rivets with countersunk heads, Fig. 5.

CORRESPONDENCE.

"BANKFIELD," CLITHEROE,
15th Sept., 1903.

DEAR SIR,

The solution of the, at first sight paradoxical, puzzle in your last issue lies in the fact that the second drawing is not correct. I enclose a corrected one.



The thin elongated space, not divided into parts of squares, which lies along one diagonal, will be found, if measured, to contain the 65th square.

I am aware this is only a rule-of-thumb solution, but perhaps it will serve.

Yours faithfully,
GEO. KING-WILKINSON.

To the Editor
Illustrated Scientific News.

Prize Competition.

ONE of the principal objects of this journal being to encourage and foster the introduction and propagation of new ideas, the Proprietor offers a series of money prizes to those who, in his opinion, send in the best and most practical solutions to certain problems, which will be set each month.

The competitor gaining the greatest amount of marks each month will be awarded the monthly prize of ONE GUINEA. But in order to encourage clever inventors, and not merely reward those who may happen to hit upon a happy idea, a GRAND PRIZE OF **ONE HUNDRED POUNDS** will be awarded—after twelve problems have been sent—to that inventor who shall have gained the greatest aggregate of marks during that period, provided he shall have gained at least *30 per cent. of the full marks* in at least six of the competitions (whether he has gained a monthly prize or not).

RULES.

1. Designs to be sent in to the office before the end of the current month, accompanied by the coupon cut from this paper.
2. The solutions sent in must be concise, yet fully descriptive of the idea intended. To comply with this they must not exceed 300 words, and not more than two simple diagrams should accompany it.
3. Solutions will be published as considered desirable by the editor.
4. Competitors may obtain patent rights for their ideas, but they must run all risk of the publication in this paper interfering with the obtaining of such rights.
5. Competitors may send in their designs under a fancy name for publication, but their true names and addresses must be inserted on the coupon, which, in the event of their winning a prize, will be published. The same fancy name must be adhered to throughout in future.
6. The same person may send in two solutions so long as a separate coupon accompanies each. All marks so gained will count for the grand prize, but the monthly prize will only be awarded for the one best solution. If the two solutions appear to the judge to be but slight variations of the same invention, marks will be deducted from the second solution.
7. Novelty of design is not a *sina qua non* (since this would be extremely difficult to prove), but only the person sending a description with the coupon is entitled to reward.
8. It would add to the value if a statement be added to say if the design has been practically tried; but to corroborate this the inventor may be called upon to give a demonstration before receiving a prize.
9. In the event of an equality of marks or any other exceptional circumstances, the proprietor will decide on the fairest method of distributing the prize.
10. Non-compliance with the above rules may disqualify a competitor.

LAST MONTH'S RESULTS.

No. 9.—Calculating Machine.

KHARKI. (**30**).
MEPHISTO No. 1 (**20**).
MEPHISTO No. 2 (**38**).
KASS. (**28**).
K. O. H (**35**).
R. FENTON (**33**).
RASILAS. (**10**).
R. FENTON No. 2 (**23**).
R. J. M. (**25**).
E. M. F. (**10**).

No. 10.—Dust Preventer.

K. O. H. No. 1 (**30**). A screen attached behind the car so as to cause downward draught.

K. O. H. No. 2 (**35**). Centrifugal air pump attached to motor shaft, sending jet of air downwards behind each wheel.

BACILLIGRAPH. (**40**). Outside ordinary tyre a metallic tyre of "V" shape is fitted to rim of wheel by small springs.

TREBLA. (**42**). Funnel-shaped pipes under car arranged to catch air in front and blow it down in rear.

KHARKI. (**25**). A band placed round wheel and round smaller pulley wheel above the ground. The band not rising so abruptly as the wheel tyre would not cause upward draught.

R. J. M. (**10**). Rotary fan under car blows air forward.

LEEDSER. (**33**). Nozzles direct jets of air to blow away dust on road in front of wheels so regulated as not to raise much dust themselves.

R. FENTON No. 1 (**50**). As dust is raised by the ascending portion of the tyre, a small screen placed close to the wheel, and at right angles to it and close to the ground, stops the rising dust.

CANTAB No. 1 (**25**). A case fixed over the whole afterpart of the wheel catches all the dust, which falls into a receptacle in the case, to be emptied at intervals.

A. C. T. (**25**). Much the same.

CANTAB No. 2 (**20**). A large receptacle fastened on to back of car, nearly reaching to ground, containing several layers of muslin, covered with "sticky liquid," which catches dust.

C. R. R. (**35**). A canvas screen arranged round back part of wheel with pad close to ground.

C. J. D. (**27**). Dust collector attached across back of car. Shield with brush fixed below it.

NEMO. (**55**). To prevent air being churned and raising whirlwinds of dust, bottom of car enclosed with flat cover, rising in front like stem of ship. Sides of car smooth and rounded to rear, wheels encased to below axles.

R. FENTON No. 2 (**40**). Mud guard continued to close to the ground.

The sum of One Guinea has accordingly been sent to

"MEPHISTO,"
C. Leslie Walker,
Mount Park Road,
Harrow.

and to

"NEMO,"
Charles H. Noyce,
147a, Northwold Road,
Upper Clapton, N.E.

The Subject for next Month, which is the last of this series, will be—

A FLYING MACHINE,

or Apparatus for raising a man in the air without the use of gas.

COUPON.

To the Proprietor, ILLUSTRATED SCIENTIFIC NEWS.

I herewith forward my idea for a solution of the problem on "A Flying Machine," according to the conditions published in your paper, and I agree to comply with those conditions.

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Address .....

.....

Fancy Name for publication .....

Date .....

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THE ILLUSTRATED

Scientific News.

A Monthly Journal devoted to Popular Science.

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The Pressure Exerted by Rays of Light.

BY J. A. FLEMING, F.R.S.

FOR nearly three centuries physicists have entertained the idea that rays of light must exert a pressure on objects on which they fall. The celebrated Kepler, in 1619, expressed the opinion that the formation of a comet's tail was due to this cause. Newton even considered the suggestion worth considering. Attempts were made to demonstrate experimentally the fact by De Mairan and Du Fay early in the seventeenth century, but without success; and later on Bennet, in 1792, tried again, but obtained only a negative result. Sir W. Crookes, in 1873, thought he had obtained evidence of it, but it was subsequently found that the operation of his radiometer depended upon the action of gas molecules contained in the bulb. In 1873, however, Maxwell proved, as a deduction from his electro-magnetic theory of light, that this pressure must exist; and starting from certain known facts as to the energy of bright sunlight, he made a calculation of the numerical value of this pressure. In 1876 Bartoli arrived, by another course of reasoning, at the same conclusion, and, accordingly, experimentalists were encouraged to attack the problem afresh, and were furnished with some clue as to the probable magnitude of this pressure. Theoretically, an approximation to its value may be found as follows:—If bright sunlight is allowed to fall on a box made of thin blackened copper, in which water is placed, it raises the temperature of the water. When this experiment is properly tried and a correction made for atmospheric absorption it leads to a knowledge of the so-called Thermal Solar Constant. According to Scheiner ("Strahlung und Temperatur der Sonne," Leipzig, 1899), the value of this Solar Constant may be thus expressed. If there were no terrestrial atmosphere the rays of the sun falling perpendicularly on one square centimetre of blackened metal would communicate to it sufficient heat to raise 3.5 or 4 grammes of water 1° Centigrade in one minute. According to Langley the value of the Solar Thermal Constant is 3 gramme-water Centigrade degrees per minute, whilst Angstrom gives the value 4, and Rosetti the value 2.5, to the same Constant. Professor J. H. Poynting considers that Rosetti's value is nearest to the true value, and we shall, accordingly, use it in the following deductions. Suppose we take Rosetti's value, then we may say that when wholly absorbed rays of bright sunshine deliver up to every square centimetre on which they fall normally at the earth's mean distance energy sufficient to raise 2.5 grammes of water 1° Centigrade in one minute. Now, one gramme-degree of heat, called one *calorie*, is mechanically equal to 42 million ergs or 4.2 joules. Hence the mechanical value of rays of sunlight at the earth's surface is 10.5 joules per minute or 0.175 joules per second, or rather more than one-quarter of a watt. This is nearly equal to 120 foot-lbs. per second on one square foot, so that on one square mile of the earth's surface on which rays of bright sunshine fall perpendicularly, power equal to about 3,000 million foot-lbs. per second is wasted. Beside this energy waste, that of all the water power in the world is insignificant. Maxwell showed that the pressure exerted by light on one unit of surface is numerically equal to the energy contained in one cubic unit of the same light-filled space. Hence, since the velocity of light is 3 by 10^{10} centimetres per second or 186,000 miles per second, the energy due to light waves contained in 3 by 10^{10} cubic centimetres of sunlit space must be 0.175 joule, and that contained in 186,000 cubic miles must be 3,000 million foot-lbs. Hence, the energy in one cubic centimetre of sunlit space must be nearly 0.00006 of an erg, and that contained in one cubic mile must be nearly 15,000 foot-lbs.

As far back as 1854, Lord Kelvin, starting from data obtained by Pouillet on the value of the Solar Constant, calculated the mechanical value of a cubic mile of sunlight as 12,050 foot-lbs. The more recent determinations of the Solar Constant seem to give a higher value. It follows, then, that rays of full sunlight exert at the earth's distance a pressure of 0.00006 of a dyne per square centimetre; for the energy contained in 3 by 10^{10} cubic centimetres is 0.175 joule.

Again, the pressure per square mile must be 3,000 by 10^6/186,000 lbs. weight, or 15,000 lbs., or nearly 7.5 tons.

It is only quite recently, however, that refined experimental investigations have demonstrated beyond a doubt the reality of this pressure due to rays of light, and shown that its observed value is in accord with theoretical deductions. In 1900 a Russian physicist, Professor Lebedew, of the University of Moscow, succeeded in demonstrating that light rays exert a pressure on objects on which they fall. The difficulty of these experiments arises from the fact that there is a conflicting action due to the impact of air or gas molecules on the illuminated object. If we suspend in an exhausted glass bulb a very light vane by a quartz fibre, and allow a ray of light to fall upon it, the heating of the surfaces causes a radiometer-like action to take place and the vane is repelled in the manner first shown by Crookes. But this radiometer action is almost wholly due to the action of the air molecules, and is not the effect of a true light repulsion alone. Lebedew endeavoured to eliminate this gas molecule or radiometer action by exhausting the bulb as completely as possible. No matter how far this may be carried there is always a large disturbance due to the residual gas, and this masks or interferes with the true light repulsion. Two very able experimentalists in the United States, Professors Nichols and Hull, have, however, recently made a more elaborate investigation, in which the action of the residual gas has been overcome by making the receiving surfaces highly polished and by allowing the light ray to impinge only for a very short time. In this way the true light repulsion has been separated out from any action due to the surrounding gas which is of a radiometer nature. Professors Nichols and Hull have published a most careful memoir, in which an account is given of researches, which demonstrate that the observed value of this light-pressure is in close agreement with the predictions of theory, and for bright sunlight is about six-tenths of one ten-thousandth of a dyne per square centimetre. It follows from this that the sunlight falling on the whole earth exercises on it a pressure of something approaching 350 million tons, forcing it away from the sun. But now, these pressures at the earth's mean distance are vastly increased if we go nearer to the sun. The intensity of sunlight at the sun's surface is 46,000 times greater than at the earth's mean distance. Hence, the light-pressure at the sun's surface is about 2.75 dynes per square centimetre, or about one-third of a million tons per square mile. It is, therefore, clear that bodies which approach the sun's surface are subjected to very considerable outward pushing forces, due to this radiation-pressure. It is easy to see that this light-pressure becomes more important in proportion as the body subjected to it becomes smaller. Consider a body of unit density and of the size and shape of one cubic centimetre placed near the sun's surface. Since gravity at the sun's surface is 27 times as great as it is at the earth's surface, this body would be pulled down towards the sun with a force of 27 grammes weight as weighed by a spring balance on our earth, or with a force of

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27 times 981 = 26,487 dynes. In consequence of the light-pressure it would, however, be repelled with a force of about 2.75 dynes. In this instance the repulsion due to light-pressure is insignificant in comparison with the attraction due to gravitation. If, however, we consider a small body of the same density, but having a diameter of one ten-thousandth of a centimetre, then its "weight" at the sun's surface would be only one billionth of that of the centimetre cube, but the light pressure on it would be one hundred millionth. In this case, therefore, the repulsion due to light-pressure would be nearly equal to the attraction due to gravity. Generally speaking, since "weight" is proportional to the cube of the diameter, whilst light-pressure is proportional to the square of the diameter, the smaller the body the more important will this light-pressure become, and the more will it overcome the attraction due to mass. But it appears that there is a limit to this preponderance. Swartschild, in 1902, computing the effect on small spherical bodies of unit density, showed that when the radiation pressure is 20 times the mass attraction the former ceases to increase. For a body of unit density this would take place when the diameter was reduced to a little less than one hundred thousandth of a centimetre. Since, according to Lord Kelvin and others, atomic diameters are of the order of one ten millionth of a centimetre, we see that a body having a diameter of one hundred thousandth of a centimetre is 100 times larger in diameter than an average atom, but this dimension is only one-fifth of the length of a wave of yellow light. Suppose, however, that the stuff of which the atom or small body is made has an intrinsic density less than unity, then the light-pressure would predominate over the mass attraction for a larger diameter. We know nothing about the absolute density of atoms or molecules, nor whether, in the state of incandescent vapour, we have to deal with discrete and separated molecules, or with groups of molecules forming small masses of larger size. It is, however, clear that this pressure due to light may constitute a very important factor in solar physics. Astronomers have long been familiar with the tremendous cyclonic and elevating action taking place in the sun's photosphere and chromosphere. The uprush of matter from cooler depths forming sun spots, and the sudden elevation of masses of hydrogen and other gases, forming the prominences, often rising in a very short time to a height of 100,000 miles or more, show that there are uplifting or repulsive forces of great magnitude in the solar atmosphere.

Astronomical opinion inclines to the view that the material of which the chief light-giving layer in the sun, viz., the *photosphere*, is composed, is carbon; and that overlying this is the heterogeneous atmosphere of metallic vapours called the chromosphere, to which the Frauenhofer lines in the spectrum are due. Over this, again, is an enveloping atmosphere of hydrogen and other gases, and, beyond, the mysterious Corona seen only during a total eclipse. Very roughly speaking, these materials are arranged in the order of their boiling points. At the lowest level we have carbon, and we may, perhaps, think of the solar photosphere as an ocean of boiling carbon overlaid with dense layers of carbon steam or vapour. The high pressure would raise the temperature of this molten carbon far above the boiling point of carbon at ordinary terrestrial atmospheric pressure. Under these last conditions the temperature of boiling carbon is that of the crater of the electric arc, viz., about 3,500° C.; but under increased pressure in the solar atmosphere it is increased to nearly 6,000° C. as shown by the experiments of Mr. W. E. Wilson (see ILLUSTRATED SCIENTIFIC NEWS for October, p. 11., "How the Sun's Temperature is Determined"). Again, above the carbon we have the perhaps cooler layers of metailic vapours, which, by their absorbing action, create the Frauenhofer lines in the continuous spectrum given by the light of the photosphere. In this ocean of liquid or dense vaporous carbon there are, no doubt, tides produced by the action of the planets and cyclonic movements produced by differences of temperature of various parts, and if any quantity of the material is carried up to higher and cooler levels it would begin to condense into carbon mist or cloud just as does the water vapour arising from terrestrial oceans. We have no good warrant for assuming that the Maxwell-Bartoli light-pressure is operative on bodies so small as single atoms, but we need not make the assumption. Suppose the carbon vapour arising from the photosphere is condensed into carbon mist or cloud, and that these particles grow by aggregation until they reach the size at which the pressure of radiation is most effective, and amounts, say, to 20 times the gravitation, then these particles would be thrust outward with enormous force. Their acceleration might amount easily to several miles per second, and as this uprush of condensed carbon takes place the particles would coalesce and grow to a size at which they once more come within the grip of solar gravitation. Then they would fall back again in a heavy storm of carbon rain. These uprushes and downpours would, no doubt, force upwards and cool the supernatant layers of metallic vapours and thus give rise to an absorbing region of lower temperature known as a "sun spot." The same process might also take place in the metallic vapour-region of the chromosphere. Any portion of it which was elevated into cooler levels would begin to be condensed into metallic rain or vapour, and these particles would then be forced still further outwards by the light-pressure, and only return again when aggregation of material had increased the size of the particle beyond a certain limit. It is unquestionable that these metallic vapours are good conductors of electricity, and from the standpoint of the modern electronic theory of electricity this indicates that there are present in the gaseous mass ions or electrons, or ultimate particles of electricity. One of the most interesting questions in connection with solar physics is the discussion of the electrical state of the sun and the electric force due to it. If the sun is in state of electrification, then it may act, as a whole, like the cathode in a Crookes tube, and throw out with great velocity streams of electrons or electric corpuscles, as suggested by Professor J. J. Thomson and by Arrhenius. The prominences may then be due to these electrical discharges taking place into the layers of hydrogen and other gases which lie over the chromosphere. It appears to be proved that mere temperature will not make a gas luminous. The luminosity in a vacuum tube is due to the bombardment of the gas molecules by the torrents of electrons shot off from the cathode. In a simliar manner the solar prominences may be simply the portions of a continuous gaseous envelope, which are rendered luminous by electric discharge taking place into them. These suggestions may serve to point out that in the phenomena of the solar atmosphere we have an exhibition on a vast scale of the effects of this radiation-pressure due to waves of light, and it is of great importance that its action in the case of very small particles, even as small as molecules, should be carefully investigated and discussed. It has been shown that masses of incandescent carbon, such as the filament of a glow-lamp, discharge negative electricity, and hence we may, perhaps, assume that the sun acts like a gigantic cathode or as a large mass of radio-active material.

During total eclipses the sun is seen to be surrounded with a silvery envelope of irregular shape, called the Corona, in which rifts, striations, and streamers appear, somewhat suggestive of an aurora. In fact, spectroscopic analysis has revealed some identities between the light given out by the Corona and that of terrestrial aurora.

Of late years an hypothesis has been developed chiefly by the Swedish scientist, Arrhenius, which takes for its starting point the assumption that there is a continual discharge of electrons from the sun. We have yet to discover if this is in any way a consequence of light-pressure, or is due to other actions.

We may, in conclusion, point out that a knowledge of the Solar Thermal Constant together with an assumption of Stefan's Law Connecting Radiation and Temperature leads to a prediction of the solar temperature which is in accord with the results of experiment.

The carbon filament of an electric glow-lamp, which gives 20-candle power, has a length of about five inches and a diameter of about one hundredth of an inch. Its surface is, therefore, nearly one square centimetre in area. When a power of 80 watts is expended in it, it gives a light of 20-candle power. Hence, the radiation is at the rate of 80 watts per square centimetre. The temperature of the filament is then known to be not far from 1,500° Centigrade. We have already seen that the solar radiation at the earth's distance is equivalent to an expenditure of 0.175 watt per square centimetre, and at the sun's surface it is 46,000 times greater, or 8,050 watts per square centimetre. Hence, the solar radiation is 100 times greater per square centimetre than that of such an electric glow-lamp. By Stefan's law for "black bodies" the radiation density varies as the fourth power of the absolute temperature. Hence, the temperature of the sun's photosphere should be greater than that of the glow-lamp filament in the ratio of the fourth root of 100 to 1. The fourth root of 100 is nearly 3.17. Hence, the absolute temperature of the sun should be $3\frac{1}{6}$ times that of the carbon filament of a glow-lamp. If we take the absolute temperature of the carbon filament as 1,800° abs., then the temperature of the sun should be 5,700° abs.; and it has been found by Mr. W. E. Wilson to be 5,773° abs. The writer of this article, in 1894, drew from the above line of argument the deduction that the solar temperature does not exceed 6,000° C. or 7,000° C., and stated it in a course of lectures delivered by him at the Royal Institution; subsequently published as a volume entitled, "Electric Lamps and Electric Lighting." More recently Professor Poynting has shown that a knowledge of the Solar Constant and the assumption of the truth of Stefan's Law of Radiation for "black" bodies enables us to predict the temperatures of the planets. Thus the surface of Mars, if an earth-like planet has a temperature of 20° Centigrade below freezing, and, according to Wien, the temperature of Neptune should be —200° C., or much below the temperature of liquid air.

The Variable Star—Mira Ceti.

DURING October this peculiar variable star may be seen at its brightest. It was the first-known star of the kind, its variability having been noted in the sixteenth century. For about a fortnight it is at its brightest, sometimes attaining to a second magnitude star, but, curiously enough, not always becoming so bright at its maximum. It then fades away for some three months and finally becomes so faint as to be invisible to the naked eye. After a period of 331 days it has again reached its maximum brightness. The variations are not at all regular, and no cause can be satisfactorily found for them. For various reasons it is improbable that the star is a double one, and the variations in brightness would seem to be due to internal effects. Though rather near the sun, the star may be observed in R. A. 2 h. 14 m. 27 s. and South Declination 3° 26′.

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Astronomical Notes for November.

THE SUN.

ON the 1st the Sun rises at 6 h. 54 m. a.m., and sets at 4 h. 34 m. p.m. On the 15th he will rise at 7 h. 18 m. a.m., and set at 4 h. 11 m. p.m. The length of the day will therefore be 9 hours 40 minutes at the beginning, and 8 hours 53 minutes at the middle of the month. The equation of time reaches its *maximum* (16 minutes 21 seconds) "before clock" on the 4th. Daybreak occurs on the 1st at 5 h. 1 m. a.m., and twilight ends at 6 h. 27 m. p.m. The Sun's apparent declination at noon on the same date will be 14° 8′ 46″ S., with an hourly variation of 48″·61, and his right ascension on the same day will be 14 h. 22 m. 6 s., the hourly variation being 9·76 secs.

Sunspots continue to increase both in number and size.

THE MOON.

Our satellite will be full on the 5th, at 5 h. 28 m. a.m., reach her last quarter on the 12th at 2 h. 46 m. a.m., become new on the 19th at 5 h. 10 m. a.m., and attain her first quarter on the 27th at 5 h. 37 m. a.m. She will be in perigee on the 10th, and in apogee on the 25th.

When full the Moon will rise at 5 h. 1 m. p.m., while at last quarter she rises at 0 h. 4 m. a.m. At her first quarter she will set at 0 h. 5 m. a.m.

Occultations will take place (1) on the 4th, when ζ Arietis (mag. 5·5) will disappear at 6 h. 36 m. p.m., at 116° from the true north point, and reappear at 7 h. 19 m. p.m., at 205° from the T.N.P.; (2) on the 5th, when 38 Arietis (mag. 5·2) will be occulted at 5 h. 59 m. a.m. at 28° from the T.N.P., and reappear 33 minutes later at 313° from that point; (3) on the 7th, when 111 Tauri (mag. 5·2) will be hidden by the Moon at 11 h. 10 m. p.m. at 140° from the T.N.P., and emerge 37 minutes afterwards at 205° from that point; (4) on the 9th, when λ Geminorum (mag. 3·6) will disappear at 8 h. 43 m. p.m. at 62° from the T.N.P., and reappear at 9 h. 28 m. p.m. at 301° from the point mentioned. (5) On the following *morning* (10th) 68 Geminorum (mag. 5·0) will suffer "eclipse" for a space of 30 minutes from 4 h. 22 m., the point of ingress being at 167° from the T.N.P., whilst that of egress will be at 214° from that point. Finally on the 14th we have (6) 75 Leonis (mag. 5·4) and (7) 79 Leonis (mag. 5·5) suffering occultation shortly after one another, the former (6) disappearing at 3 h. 36 m. a.m. at 167° from the T.N.P. and reappearing 35 minutes later at 233° from the point named; and the latter (7) being timed to vanish at 7 h. 17 m. a.m. at 142° from the T.N.P., and reappear at 8 h. 23 m. at 268° from that point.

The Moon will be in *conjunction* with Venus on the 15th, Mercury on the 18th, Saturn on the 24th, Mars on the 23rd, and Jupiter on the 28th.

THE PLANETS.

Mercury, though technically a "morning star" throughout the month, in so far that he rises before the Sun until nearly the end thereof, cannot be said to be favourably situated for observation after the first week. On the 7th he rises at 6 h. 13 m. a.m., with R.A., 14 h. 13 m. 58 s., and S.D. 12° 14′ 54″. His apparent diameter on this date will be but 5″·0.

Venus will be a "morning star" throughout the month, and will prove a fine object for those who care to carry on their astronomical studies in the early morning hours, rising on the 5th at 2 h. 49 m. a.m., and on the 26th at 3 h. 7 m. a.m. Her R.A. on the 17th will be 12 h. 29 m. 56 s., her S.D. on the same date being 2° 4′ 32″, the planet showing an apparent disc 28″·0 in diameter. She will be at her *greatest elongation west* (46° ·44′) on the 27th.

Mars is still *astronomically* an "evening star," but the remarks made with regard to this planet in last month's "Notes" apply equally to the present occasion.

With regard to Jupiter, this planet is still favourably situated for observation in the evening, though he *souths* as early as 7 h. 30 m. p.m. in the middle of the month. On the 17th his declination will be 7° 45′ 23″ S., his R.A. being 23 h. 1 m. 24 s. The planet still shows a disc whose apparent diameter will be over 40″ in the middle of the month.

Saturn will also be an "evening star," but will require looking for early, as he sets at 9 o'clock in the middle of the month. His R.A. on the 12th will be 20 h. 24 m. 47 s., whilst his S.D. on the same day will be 19° 59′ 58″. His apparent diameter will be only about 15″, and altogether this planet will not prove a very attractive object.

Uranus, nearing *conjunction* with the Sun in December, is now practically invisible for the purposes of the ordinary observer.

Neptune is still becoming more favourably placed for observation, as he *souths* at the end of the month at 2 h. a.m., with N.D. 22° 15′, and R.A. 6 h. 23 m. 6 s. His apparent diameter will be 2″·7.

The *minor planet* Vesta continues to improve in position for observation throughout the month. On the 10th she will rise at 5 h. 55 m. p.m., having R.A. 4 h. 26 m. 21 s., and N.D. 13° 41′ 46″. On the 30th this planetoid rises at 4 h. 5 m. 39 s. and N.D. 13° 20′ 17″. She will be in *opposition* to the Sun on the 25th.

THE CONSTELLATIONS.

At this season the observer will note the fact that the "Milky Way" (*Galaxy*) spans the sky with a resplendant arc, running roughly east and west.

Towards the middle of *Via Lactea* Cassiopeia will be found almost at the zenith. Slightly to the southward Andromeda will be seen, and directly below this constellation lie those of Pisces, Cetus, and Sculptor. Eridanus flows along the south-eastern horizon, and leads our gaze to where the bright groups of Orion, Taurus, and Gemini are just rising in the east. There is an added interest to Orion at the present time owing to the doubt as to the variability of α Orionis (Betelgeuze).

Ursa Major is now low down on the northern horizon, whilst Lyra is fast declining in the west.

METEORS.

That somewhat disappointing group of meteors known as the *Leonids* are due between the 13th and 15th, their radiant-point being situated in α 150° + δ 22°. It is deemed probable that there may be a fairly good display this year. They are best observed in the morning hours.

Another interesting group of meteors is also due this month—that of the *Andromedids*, on the evenings of the 23rd and 24th. The radiant is situated in α 25° + δ 43°. There should be a fair display of these objects this season.

ZODIACAL LIGHT.

This phenomenon may still be looked for in the morning during the early part of the month.

Wanted a Respirator.

THERE are several dangerous trades in which the dust inhaled by the workpeople is in the highest degree injurious and in some cases fatal. In the white lead industries the lead is taken into the system largely as dust; in the file-grinding trade, in some textile factories, and, as more lately has been shown, in the Cornish mines dust is the chief factor in producing phthisis or diseases akin to consumption. An efficient respirator seems to be an invention imperatively called for; but it is a melancholy fact that though as far back as 1822 the Society of Arts awarded its gold medal to Mr. J. H. Abraham, of Sheffield, for a "magnetic guard" to protect persons employed in dry grinding, the respirator, though admittedly efficient, never came into practical use. It is alleged that the workpeople refused to use it because they feared that the lessened risk would reduce their wages; and if that were the case it is a melancholy testimony to the distrust which the employers had engendered in the minds of those whose health ought to be one of their chief concerns. However, after eighty years more, educating influences may have brought about more civilised conditions; and, at any rate, the Society of Arts have thought the time ripe for again offering a prize "for the best dust-arresting respirator to be used in dusty processes and in dangerous trades." The apparatus will be required to fulfil the following conditions: It must be light and simple in construction; it must be inexpensive and its filtering material easily cleansed or renewable; it should not allow air to enter the nostrils or mouth except through the filtering medium; it should not permit expired air to be re-breathed; and it should not hinder respiration when worn for some hours. It is also desirable that it should not be unsightly. Such an invention should be of great use, even of national service; but it will still leave untouched the other problem of a chemical respirator designed to arrest poisonous fumes.

Automobile Horse Power.

IN the British Association Committee's Report on the Resistance of Road Vehicles to Traction, which is one of the important investigations taken up in recent years by the members, and annually reported on, were some conclusions read by M. Lavergne to the Automobile Congress in Paris. M. Lavergne has shown how great is the reduction of weight in proportion to horse-power that has taken place during the last eight years. In 1895 Levassor made the run from Paris to Bordeaux in a 4-horse power car weighing about one ton, or 1-horse power per 550 lbs. dead weight. In 1896 this was reduced to 365 lbs. per horse-power; in 1900 it fell to 90 lbs. per horse-power. In the recent Paris-Madrid Race, M. Gobron Brillie appeared with a 100-horse power car, the weight of which represented only 22 lbs. per horse-power. This weight has been still further reduced in the case of motor bicycles, reaching as low a figure as 17½ lbs. per horse-power. But there is not a corresponding increase in speed. In 1901, M. Fournier made over 53 miles per hour with a 28-horse power Mors; last year M. de Knyff only slightly exceeded 58½ miles an hour with a 70-horse power motor—that is with an additional 40-horse power. M. Lavergne concluded that an extremely powerful motor must be accompanied by a comparatively heavy load, otherwise the wheels did not bite well, and energy was wasted. The modern racing car skimmed along the surface of the road without sufficiently close contact between the wheels and the ground.

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The Marienfelde-Zossen High Speed Trials.

By DR. A. GRADENWITZ.

WHEREAS all over the world there are numberless tramways and suburban railways worked by electricity, the steam locomotive still reigns almost unrivalled in the field of electric traction on standard gauge railways. Now, in spite of the still unexhausted possibilities of the steam locomotive, which so far was able to meet all the requirements of modern traffic, engineers gradually become aware of the practical limits opposed to its development. It seems, in fact, that on account of the heavy specific weight of this engine, speeds of, say, 95 miles, are all that can possibly be hoped from the steam locomotive.

Apart from the special advantages inherent in electric service, the problem of electric high speed traction appeals, therefore, to the mind of everyone interested in the progress of modern life. It was considerations of this kind that induced, four years ago, two of the most prominent exponents of electrical engineering, Mr. Rathenau and Mr. Schwieger, who happened to meet on a journey from Berlin to Milan, in a sleeping car, and to exchange their views on the subject, to give rise to a combine of the two greatest electric firms in Germany, the Siemens and Halske Co. and the Allgemeine Elektricitats Gesellschaft. A special concern was soon afterwards started under the firm of "Studiengesellschaft für Elektrische Schnellfahrten" with a view of thoroughly studying the problem of high speed electric traction and ascertaining both its condition and practical limits. The Marienfelde-Zossen military railway near Berlin was lent for the purpose, and some of the leading German banking firms, as well as the authorities concerned, gave their support to the new undertaking. The two above-mentioned electric firms were each to construct one trial motor car, and the final aim of the trials was attaining speeds as high as 200 kilom. (125 miles) per hour.

The Electric Equipment of the Cars.—In order to ensure perfect safety of both passengers and superintending persons, all the apparatus and conductors were arranged below the floor or the ceiling of the car, both being protected by grounded metal sheets. Moreover, instead of being operated immediately by the hand of the motor man, a special source of power was provided for the purpose of controlling the electric apparatus. As compressed air was used for the brake, it was chosen also as a source of power in this connection. The various units constituting the electric apparatus of the car had to be arranged so as to distribute uniformly the weight, instead of concentrating the same on one point, this ensuring, at the same time, a ready dissipation of the heat generated by the different power losses. The electric equipment was accordingly divided into two units, each comprising:

1. Two motors with two sets of resistances and two exciters, two switches, and two fuses;

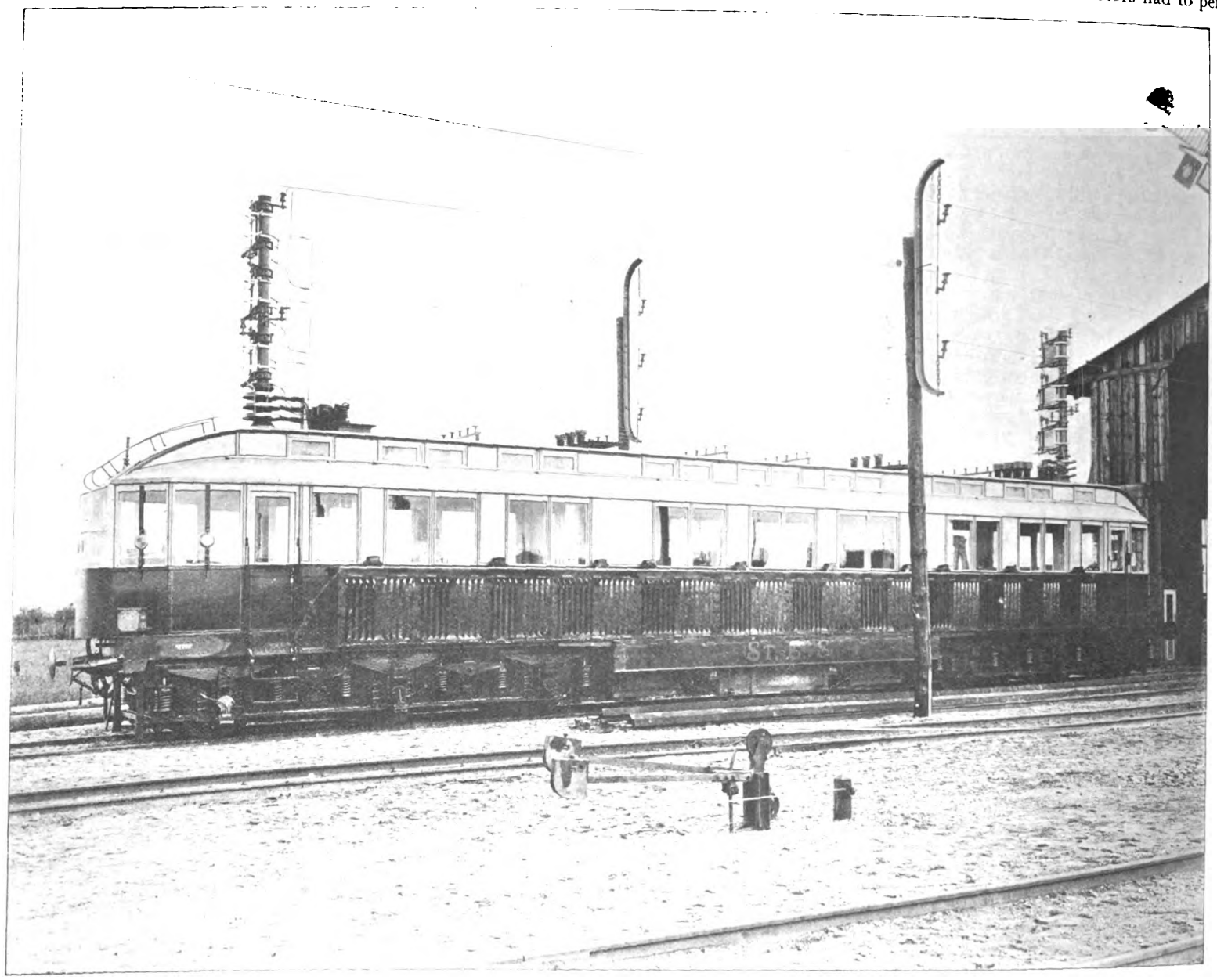
2. Two large transformers with secondary triangular and star switches, as well as primary high tension switches and high tension fuses;

3. One air pump with small transformer fuses, and one air reservoir;

4. One collector;

5. One motor man's stand, including the compressed air devices for the apparatus and the measuring instruments.

The running wheels are 1,250 mm. in diameter; still the number of revolutions is so high as to make an immediate mounting of the motors on the axles advisable. Each of the four motors had to perform the fourth part of the total 1,000-h.p. necessary according to previous calculations, to drive the car. According to the same calculations, the performance of the motors in starting should be three times greater, viz., about 3,000-h.p., this increase being obtained by higher load.



The Car.

The Overhead Line.—The accompanying figures show the arrangement of the overhead wire, the middle of the pole being about 2½ m. distant from the middle of the track, and the three horizontal wires conveying the current being about 1 m. apart. The whole of the line is divided into sections of about 1 km., each of which is provided in the middle with a device for compensating losses in tension. The zero of the system is connected to the earth and to the rails. As the various parts intended for bearing the insulators on the out-rigger are connected by articulations, the suspension point may be horizontally displaced, to a certain extent, as the collector presses against the horizontal wire, a satisfactory and simultaneous contact between the three horizontal wires and the contact arcs being thus possible. Lightning rods as well as safety devices are provided for in case of a fracture, by which the wire is automatically put to earth.

The Collectors.—The collectors have the form of masts supported by the car and movable round their vertical axis. The mast is made up of two Mannesmann tubes about 200 mm. in diameter, slipped one over the other, and susceptible of being rotated by means of a double-

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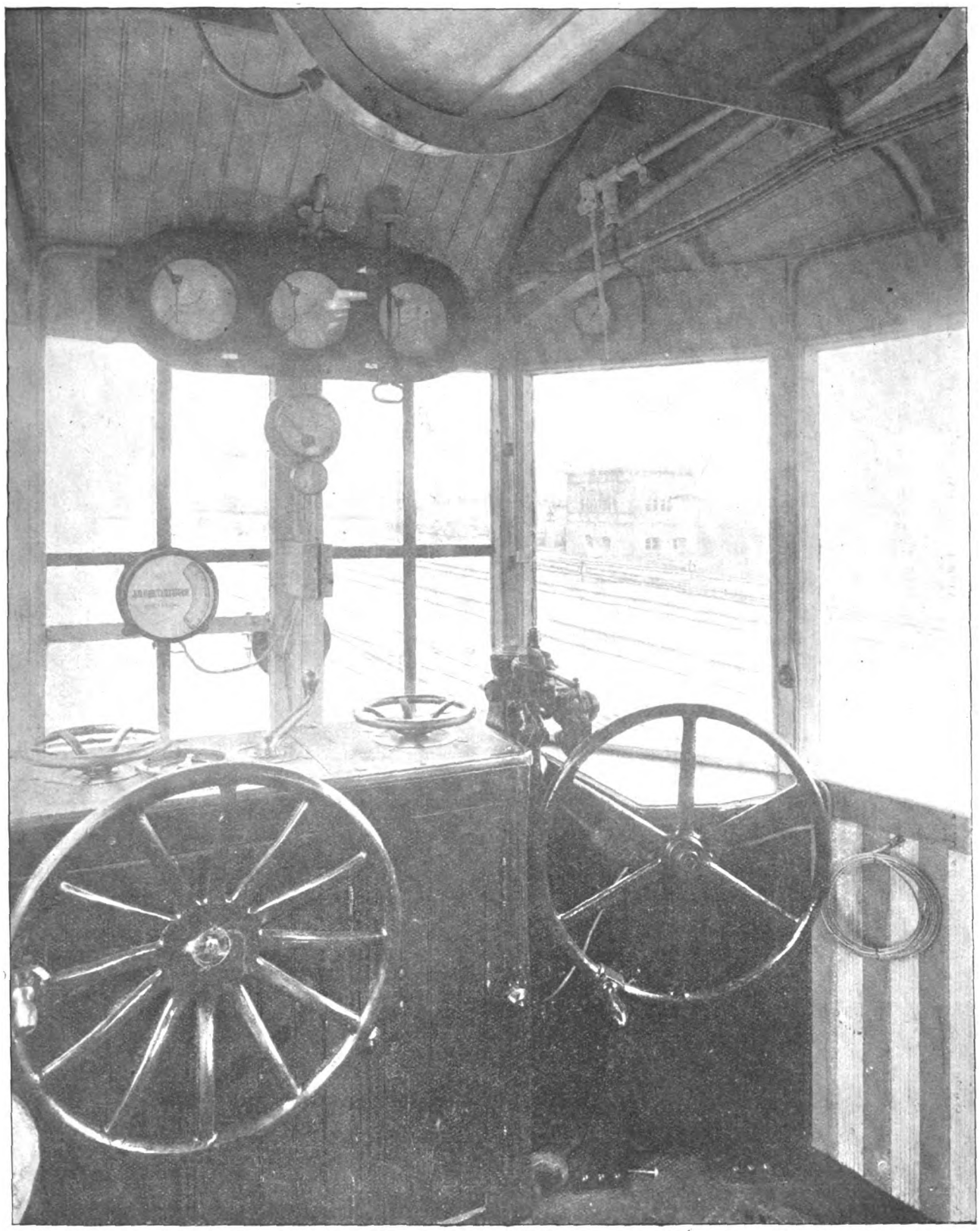
toothed gearing operated by means of a crank from the motor man's stand. The sliding rings are attached to the upper insulated tube. Contact springs, screwed by means of hard rubber insulators to a special flat iron frame, are fixed to the three sliding rings. Into the insulating tube and partly into the lower part of the collector the upper tube is placed, so as to be readily dismounted after loosening some screws. This tube bears at central distances of 1 m. each three rotating axles for the contact arc proper. The wind pressure against the arc on one side of the rotating axis is compensated by means of vanes attached to the other side of the same.

The Permanent Way had originally a bed of gravel, which, however, was eventually replaced by a bed of finely pounded basalt, in connection with this year's experiments.

The experiments made in the course of 1901-1902 allowed, in fact, of speeds as high as 150-160 km. being reached. As, however, the cars were found to undergo considerable oscillations and shocks with these speeds, in addition to deflection of the rails and cracks in the sleepers, it was thought advisable to rebuild the track, when the heavy permanent way used with Prussian rapid railways was adopted. Special safety devices against derailments were provided, made up of two horizontal rails placed 50 mm. above the running surface, which, however, so far, were never found to be operative, this showing the usual types of permanent way to be fully suitable even with the highest speeds reached in connection with the present experiments. In addition to the rails, the turntables were thoroughly revised, and by the use of compensating levers similar to those used in connection with locomotives, a uniform distribution of the weight of the car over the various wheels was ensured. These modifications gave excellent results, the cars running now at the maximum speed as steadily as formerly in the case of speeds of about 130 or 140 km. The overhead line had also to be modified in some points, so as to avoid fractures and short-circuits, as formerly sometimes occurred.

The experiments made in the course of 1901-1902 had shown the electric equipment to be fully suitable, and the distribution line to give excellent results for speeds up to 160 km. per hour. The results of the above improvements were shown in connection with the recent trials:



The Motor Cab.

the track not only resisted fully against the strain to which it was put by ever-increasing speeds, but the cars would run with a safety and steadiness such as to make shocks of the rails nearly insensible.

After reaching speeds as high as 189 km. per hour at the end of September last, it was anticipated that resuming the experiments at the beginning of October would lead to the maximum speed of 200 km. being finally reached. This was actually the case on October 6, the event being watched by a great number of lookers on. In fact, the morning suburban trains leaving the Potsdamer Platz Ringbahn station, in Berlin, were filled both with engineers and lay people, anxious to attend the trial and going to one or other of the military railway stations, if they were not to take part in the experiments, this being a privilege of only a few. The distance between Marienfelde and Zossen, being 23 km. in length, was repeatedly traversed in not more than eight

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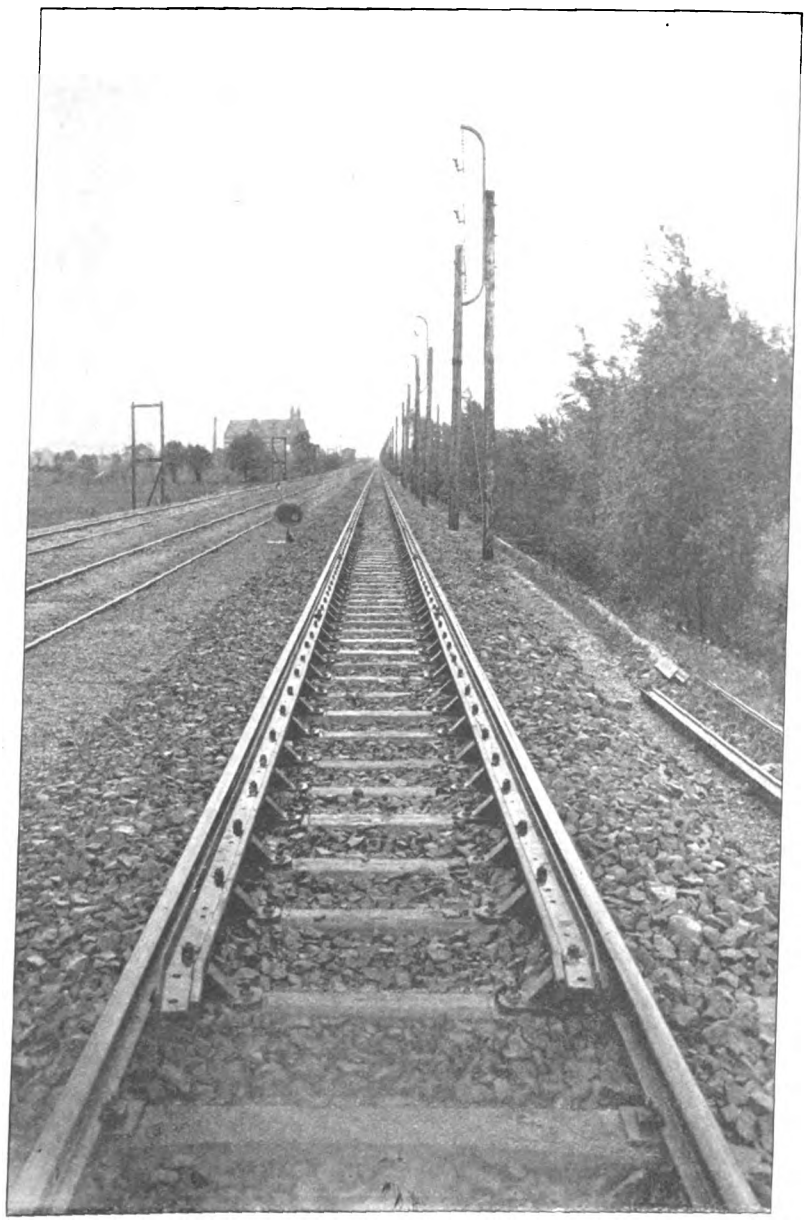
minutes, including starting and braking, the maximum speed of 201 kilm. (126 miles) being actually reached on the section Mahlow-Dahlwitz-Rangsdorff, traversed in 1½ minutes, throughout about 5 km. The mean speed of 175 km. per hour would enable the journey between Berlin and Cologne (577 km.) to be completed in about 3¼ hours, whereas the quickest present trains take fully 9 hours.

From a car running at such exceedingly high speeds, the neighbouring objects, of course, will disappear from view. Though the motorman would be able to distinguish obstacles on the track, this would be of little use, the braking distance, *i.e.*, the distance from the beginning of braking to the stopping of the train, being 2 km., and 2,400-h.p. having been necessary to obtain the desired speed. Lookers-on could just distinguish the presence of men in the car; before, however, being able to fix their figure the car had long ago disappeared from view. Though the track is very straight, there elapsed, at most, ½ min. between the first appearing of the train and its passage and thence to the instant of its disappearance on the horizon.

The difference between electric and steam operation of railways, from an economical point of view, is shown by the following calculations made by Dr. Reichel: a steam railway train, comprising a steam locomotive and six trailers, will weigh 330,000 kg., containing 168 seats, and consuming 1,400-h.p. at full speed; on the other hand, an



The Track.

electric train, consisting of one motor car and four trailers, will have a weight of 260,000 kg., containing 180 seats, and consuming 1,000-h.p. The first cost is about equal in both cases, being about £20,000. The cost of operation of the train itself is for each 100 kilo. per seat 6½d. in the case of steam locomotives, and about 6¼d. with electric operation. Hence, it may be inferred that electric railways are by no means so economically inferior to steam railways as many are inclined to think. Anyhow, the Zossen-Marienfelde experiments have shown the practicability of speeds as high as 200 km. per hour, and this, no doubt, will not fail to have some influence on the future development of railways at large.

With the last successful high speed trials, the Siemens car was allowed to work, whereas the car of the Allgemeine Elektricitats Gesellschaft is being put into operation now. As the latter car in 1901-1902 gave quite as satisfactory results as the Siemens car, it is hoped to reach the same speed, and later on to continue the experiments regularly during the hours of lesser traffic, using alternatively either of the two trial cars.

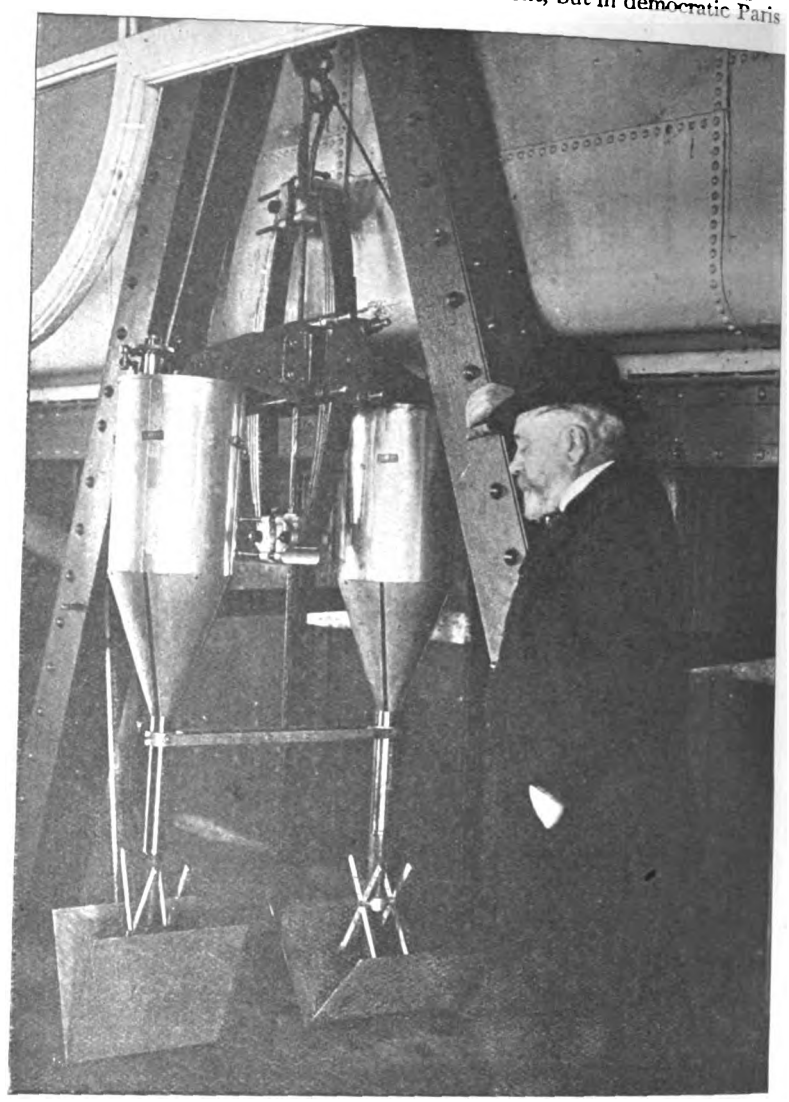
We wish to give our best thanks to Dr. W. Reichel, chief engineer to the Siemens and Halske Company, to whose courtesy we are indebted for part of the above data, as well as for the illustrations given here

The Eiffel Tower.

Its Uses and Prospects.

By M. W. DE FONVIELLE.

ON the first of August some startling information was circulated by some correspondents of the English Press in Paris, and proved authentic. One of the most influential commissions appointed by the Prefet de la Seine for giving advice on public affairs had passed a resolution for utilising part of the Champ de Mars, the largest open space in Paris, for building purposes. In monarchical England the idea of erecting flats for the well-to-do in Hyde Park or Kensington Gardens could not be entertained for a moment, but in democratic Paris



The Eiffel Tower—M. Eiffel and the Instruments on the Second Platform.

any bargain is welcome to the Hotel de Ville that will leave a handsome surplus in their hands. The proposal to destroy the only large open space in Paris available for public meetings of any kind will not be carried without opposition, and it must be hoped that this historical site may yet escape. The Paris city engineers cannot be said to exhibit too much reverence for buildings. A few years ago it was proposed to demolish the Paris Observatory in order to extend the Luxemburg Avenue, and sell building sites on each side for lofty mansions. This scheme came to nothing, and the venerable monument associated with so many well-known names was saved. But the Palais de l'Industrie was destroyed during the preparations for the Exhibition of 1900, in order to enable people walking in the Grand Avenue of the Champs Elysees to see the front of the Hotel des Invalides. It is at present suggested that the Eiffel Tower is a hideous object, and a disgrace to the picturesque city in which it stands. The Eiffel Tower is nearly as well known in England as in Paris, where Englishmen are its most frequent visitors. If this masterpiece of architecture in iron had not a weight of more than 17,000 tons of metal, it would be advisable to transport it as a whole to England were it ever to be banished. But in that case M. Eiffel would do better to build a new one in London himself. I do not suppose it would be difficult to raise the sum of £300,000, which was spent in giving to science a laboratory at a distance of 984 feet from the Champs de Mars building ground. But there is little chance of the Paris city engineers succeeding in their scheme of demolition, for the Eiffel Tower has found its determined defenders.

When the rumours of its proposed destruction first were circulated the French Association, an offspring of the British Association, and an influential body, was holding its meeting for 1903 at Angers. On the following morning the two sections of physics and meteorology held a common sitting, at which was passed a unanimous resolution asking the Association to vote against the demolition of the Tower. This

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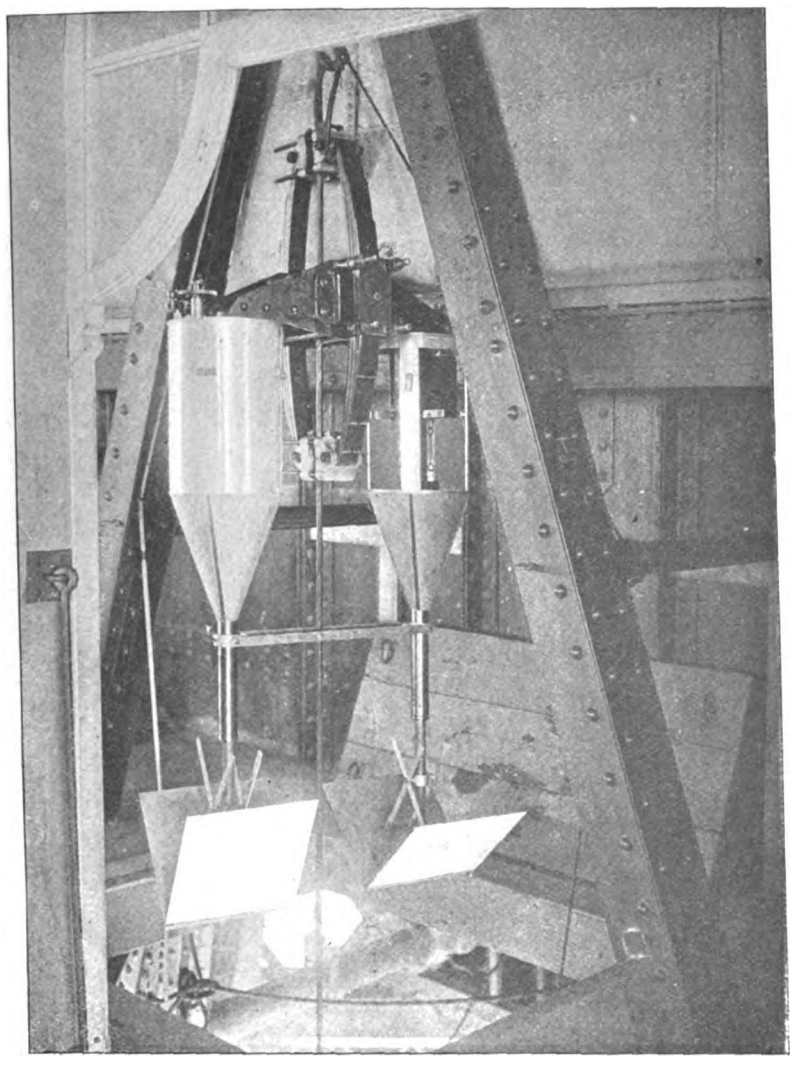
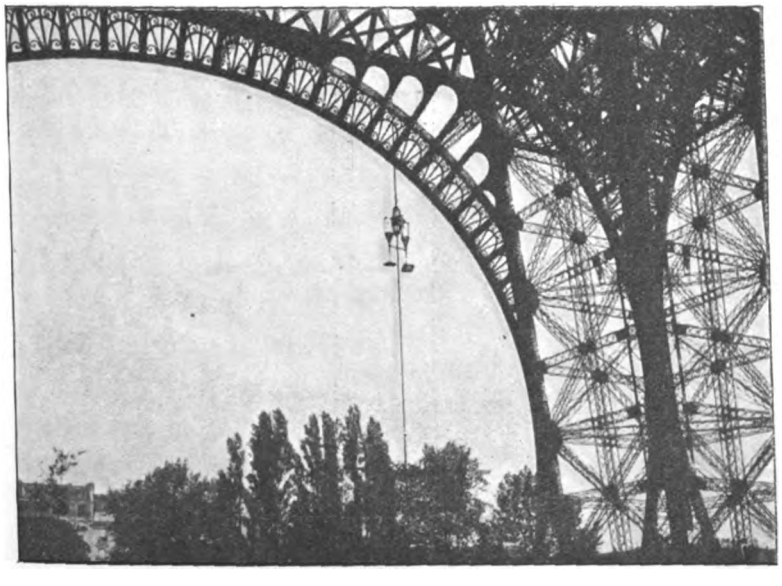
was also carried unanimously, and copies of the resolution were sent to the Prefet de la Seine and to the several learned societies in France. Since then the French Society of Aërial Navigation has adopted the same resolution, and has appointed a commission to inquire into what uses the Champ de Mars and the Eiffel Tower could be put for Aëronautical purposes. Other societies are to follow suit, and it is expected that the Academy of Sciences will follow their example. Two of its



Eiffel Tower Instruments.—The registering apparatus had been photographed when passing through the hole of the first platform.

most illustrious members, M. Janssen and M. Mascart, having defended the great iron Tower when it was threatened for the first time by Parisian aesthetes at the time when it was being built.

We cannot here enumerate all the work which has been done on the Eiffel Tower in the determination of physical constants, or the many other scientific uses to which it has been put, and for which no other place would have served so well. But it may here be stated that the



The Velocity Apparatus descending.

upper part of the building, which extends above the third terrace, is entirely devoted to the purposes of the French Meteorological Office. In itself, the upper meteorological structure has vertical dimensions of about 100 feet. There is to be found the lighthouse and the registering instruments, whose indications are transmitted to the meteorologists to guide them in their daily weather forecasts. The transmission of the indicators situated at about half a mile distance is made continuous by means of electric communication. But for their better control, an official of the Bureau ascends 2,000 steps nearly every day, even in winter, when the lifts are not in operation, for taking direct messages and keeping the apparatus in working order.

Experiments have been made for utilising the Tower as a station for wireless telegraphy. Its success has not hitherto fulfilled expectations, as it has not been possible to place antennæ above the point of the lightning conductor, which terminates the whole structure, but which might be removed without endangering its security, as the Tower is itself the best of all lightning conductors. When such an operation has been performed, it is confidently expected that it will be possible to exchange continuous communications with the Crystal Palace Tower or Great Wheel.

In war time the Eiffel Tower would be invaluable, as it commands a view of a whole province round Paris, and would be the means of keeping open communication with the banks of the Loire. The accompanying photograph, taken in the direction of Notre Dame, shows with what exactness the impression can be taken at a great distance with a powerful object glass. Among the novelties which are attracting public attention, we must instance the experiments made by M. Eiffel for studying the resistance of the air at a great velocity. It is a subject of which little is known, and has important bearings on mechanics. Our photographs illustrate this apparatus, at its starting, and during its descent. In the first photograph M. Eiffel is to be seen on the right of the instruments.

An Experimental Tank for Shipbuilders.

MOST people are familiar with the fact that the late Mr. William Froude, F.R.S., introduced, in 1870, a method of experimenting upon the complicated circumstances that enter into the behaviour and life-history of ships moving through water, by the use of models worked in a tank. An experimental tank of the kind was erected for him at Torquay by the Admiralty, this structure being 250 ft. long, 33 ft. wide, and 10 ft. deep. Over the tank a truck could be run in railway fashion, at varying speeds, the model being drawn along on the water beneath, while suitable apparatus indicated the resistance.

The prime importance of the information deduced from the Torquay trials was fully recognised in naval and official circles, and, since 1886, the Admiralty has systematically continued the work in a new and specially-fitted tank at Haslar, Gosport, under the superintendence of Mr. R. E. Froude, F.R.S., the distinguished son of the original investigator.

The Haslar tank is about 400 ft. long, 20 ft. wide, and 9 ft. deep. The models employed are made of hard paraffin wax, and are generally constructed to a length of 14 ft.

The experiments conducted at this station, and the cognate researches arising therefrom, have enabled naval architects to design and float great naval craft with astonishing success, since problems of propulsion, economy of power, surface friction, or other resistance offered to ship movements by waves in motion have been thereby more clearly realised. Considerations of this nature now belong, in fact, to the territory of strict scientific enquiry, the forecasts of the model leading, so far as human skill can safely interpret, to the adequate performance of the ship itself. In particular does this apply to the vessels of the Royal Navy, for it is certain that all our newer types commenced their babyhood in model form.

In the mercantile marine, however, the private shipbuilders are at considerable disadvantage in consequence of the lack of proper facilities for experiments on the ships they design, though it is true that at least one great firm (Denny's) maintain a tank for models.

For the past three years the Institution of Naval Architects has laboured to bring about reform in this connection. In the early part of 1902 they had constituted a committee charged to consider the feasibility of raising subscriptions for the establishment of an experimental tank for the shipbuilders of the United Kingdom, where models of proposed designs could be tested for resistance and other qualities. At first it was thought that the Admiralty would, under proper restrictions, permit the use of the Haslar tank. Private constructors in the United States enjoy this privilege in the Government tank at Washington, providing there is a payment of fees. So, also, at Spezia and St. Petersburg. Opportunities for experiments could not, however, be conceded, and it was, therefore, incumbent to look around for a site on which to erect an entirely new tank. The National Physical Laboratory at Bushey, standing in thirty or more acres of freehold land, seemed a most desirable one on general grounds, and also as regards accessibility. Moreover, an alliance in some measure with the Government standardising institution suggested important advantages.

The Laboratory Board as the next step formally approved the proposed tank installation on part of their property, as well as that its maintenance should be vested with them, subject to various financial and other safeguards involved in the working operations. Last year, too, the scheme received the advocacy of the Prince of Wales. It was estimated that at least £15,000 would be required for constructing and equipping the tank, and this sum, it was believed, would be forthcoming from interested shipowners, shipbuilders, and others. Notwithstanding the efforts of the Institution of Naval Architects, acting

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in conjunction with the Institution of Marine Engineers, it appears that a difficulty exists in raising the necessary funds for building the tank. The shipowner is said to be waiting upon the shipbuilder; the latter is concluded to hesitate through doubts concerning the value of experimental research for his concerns. Truly an old story.

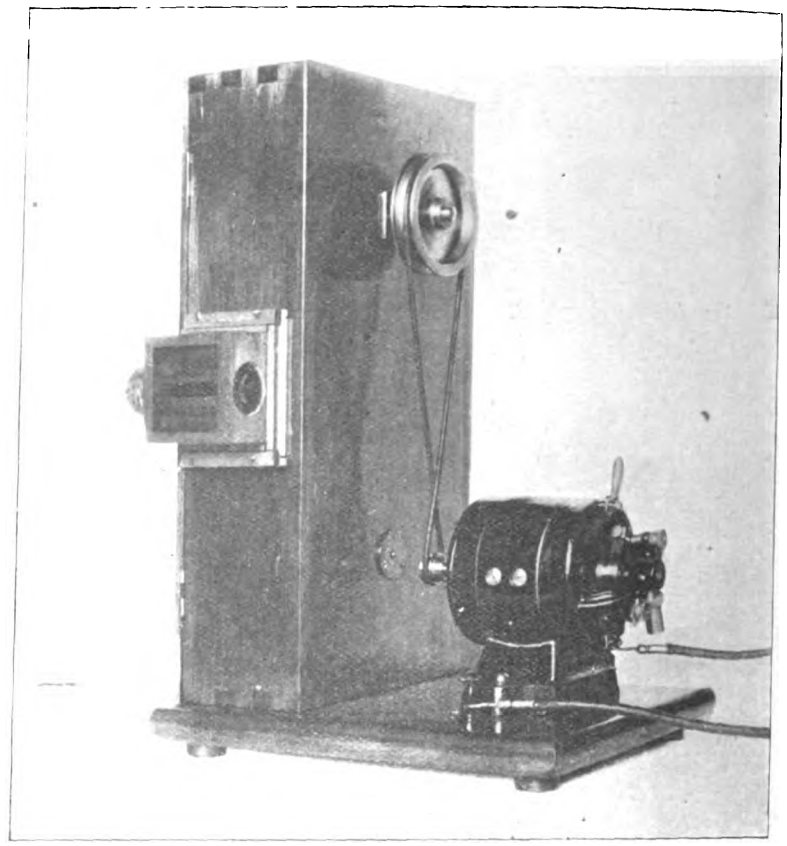
In this unpleasant position, therefore, the scheme at present remains, apparently destined to be added to the list of stillborn industrial projects of national aim unless actively piloted into realisation, as was the National Physical Laboratory itself by the aid of loyal scientific helpers. A recent pronouncement by the Board of Admiralty strongly emphasises our mercantile deficiency, and provides some bluntly-expressed opinions. It is considered that very great advantage would accrue through the establishment of an English experimental station in which, both by model trials and analyses, the relative performances of merchant ship forms might be systematically determined and recorded. Further, that such an institution would give greater confidence and precision to the design of future ships.

The view may be held that shipbuilders will hesitate to entrust designs and models to the care of outside persons in no way connected with their own yards—individuals who can afford no prior guarantee of reliability and discreet conduct. But it is not unreasonable to think that the security against leakage of ideas would be at least as jealously enforced in an establishment affiliated to a national institution with the admitted prestige of the Physical Laboratory as in any private shipyard, and such an authority might certainly be expected to devise special precautions for the due promotion and regulation of the experimental work carried on under its auspices.

New Types of Phonograph.

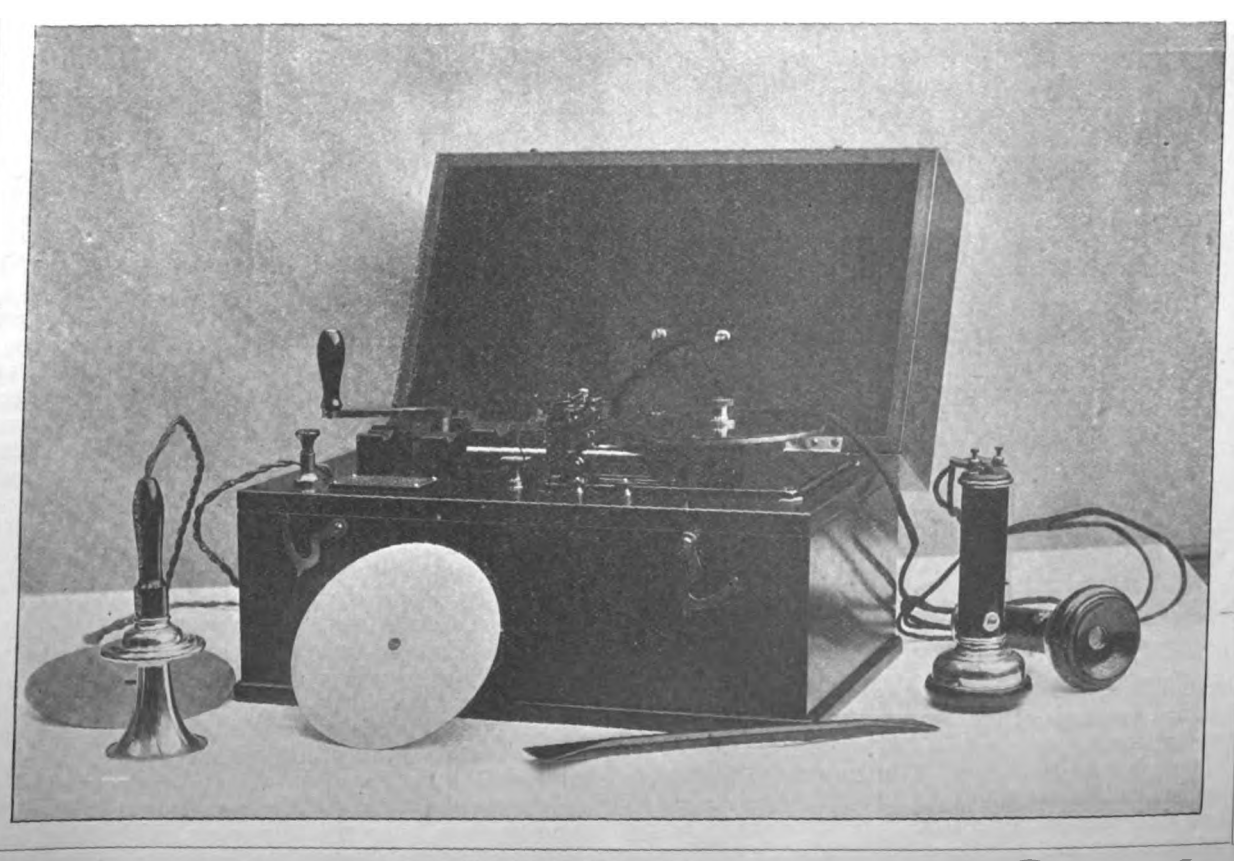
AMONG recent solutions of the problem of fixing sound on and reproducing it by means of a machine, V. Poulsen's telegraphone is one of the most satisfactory. This apparatus, as is known, records sound waves on a steel wire or strip wound on a cylinder. The telephonic currents produced by a microphone are led to an electro-magnet in front of the poles of which the above spiral or strip is moved, the relatively weak currents exciting magnetism in the different parts of the steel wire as the latter passes by. As this magnetism is permanent, language may be fixed by this means. When the words recorded are to be reproduced, it suffices to run the above steel wire in the same direction, in front of a similar electro-magnet, to the windings of which a telephone is connected. As the different parts of the wire show differences in magnetism, there will, in the windings of the electro-magnet, be produced corresponding induction currents, which, in turn, act on the telephone. The inventor recently, before the Copenhagen Industrial and Hygienic Congress, gave an account of the improvements made in connection with this apparatus since the appearance of the first type, as well as of the hopes he attaches to the telegraphone. The fact that a somewhat intense respiration will easily be recorded and reproduced by the apparatus is illustrative of the sensitiveness of the latter. In the latest type of apparatus, this cylinder is replaced by a round and thin steel disc, which may easily be put into an envelope and sent anywhere in order to be reproduced by another apparatus. As a comparatively large amount of writing may be recorded on the unit of surface of these plates, the apparatus may, if desired, go on talking for a long time. Many thousands of reproductions may be made, without their being weakened to any appreciable degree. Moreover, many copies may be taken of the language recorded.

Another interesting form of apparatus utilizes the photo-electric properties of selenium. The photographone, designed by Herr Ruhmer, Berlin, is mainly a cinematograph in its simplest form. In a box impermeable to light there are two rollers, over which a photographic film is run by means of an electromotor at a constant speed, passing through the focal line of a specially constructed cylinder lens, concentrating the illumination from a *speaking lamp* on the moving film. After the record has thus been made, the film is in the usual way developed and fixed, when a strip of constant width with alternatively dark and bright vertical lines, closely corresponding to the variations in the luminous intensity of the light source placed at the sending station, and hence to the sound waves transmitted, will be obtained on the developed film.



Ruhmer's Photographone.

In order to reproduce language, the photophonogram obtained in this way, or else a positive taken from it, is moved in the same manner



Poulsen's Telegraphone.

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and at the same speed as when the record was made, while the beam from an ordinary projection lamp is thrown on it. The differences in the shades of the film will produce an unequal absorption of the light rays from the above lamp, and, accordingly, a variable illumination of a selenium cell placed behind the film. The latter, therefore, will be submitted to similar variations in the illumination as in the case of a direct illumination from the light force of the sending station. These luminous differences are converted again in variations of the resistance, giving rise to oscillations of current, which actuate the telephones inserted, and thus reproduce the telephonogram. If the distance between the sending station and the photographone be small, this apparatus constitutes a novel photographic phonograph, the lamp used as speaking lamp being employed with the reproduction as projection lamp for lighting the film, whereas in the case of a greater distance this apparatus embodies at the same time a solution of the problem of transmitting and recording simultaneously the sound waves of the

New forms of Telegraphone.—Ruhmer's Photographone with Portrait of Herr Ernst Ruhmer.

human voice. Besides the enormous sensitiveness of this photographic method, the high amount of words which can be recorded by the same film, there is the additional advantage of the equal practicability of positives and negatives. From an original negative any number of equivalent copies (positives) may thus be taken.

The inventor has even succeeded in composing from copies of single sounds whole words and phrases as well as in reproducing them as a whole in a most perceivable manner, thus rebuilding human language in a cinematographical synthetical way. The field thus opened may prove interesting in connection with acoustical and linguistic investigations.

Electrical Notes.

AT the World's Fair ten years ago, and at the Paris Exhibition more recently, the moving platform has been utilised successfully as a means of locomotion. The Paris venture was extremely popular and very profitable; but though some such system was suggested as suitable for use on the Inner Circle, Mr. Yerkes has elected in favour of the comparatively old-fashioned direct current electric traction; and it has been left for the United States and New York to make the first experiment in putting down the moving platform as a permanent way. The New York Rapid Transport Commission has decided to adopt an electric moving platform for a New York Tube, and then to run it across the Williamsburg Bridge. The wheels of the moving platform will be stationary; the rails which run on them will move. There will be three moving platforms travelling side by side. The passenger will step from the station and stationary platform to one which is moving at three miles an hour. He will then make his way to the second platform moving at six miles an hour, and from that to the third and final platform, which is moving at nine miles an hour. On the third platform will be the cars, which will be very short and will have seats crosswise and facing the direction of motion. The whole thing has been carefully worked out even to the amount of the fare, which is to be a uniform three cents for all stations, and it is calculated that at nine miles an hour the moving platform will be able to carry 47,500 passengers in the hour. It may carry more than that when New York is in a hurry to get to business.

Though Mr. Kipling has hymned the rhythm of machinery, poets among the engineers have been few and far between, and the most conspicuous effort in this direction remains Rankine's famous "Song of the Twelve-Inch Rule," in which he denounced the metric system with great vigour. A poet does, however, make an appearance from time to time in the pages of the *Electrical Engineer*, and from his last contribution, which is a song in exaltation of the future of the turbine engine, we feel impelled to quote the following lines:—

"You may talk of any engines
Of reciprocating type,
That have ever been constructed
Or have blossomed forth to life,
From the stately moving triple
To the giddy high-speed thing
Which runs with peace angelic,
Though, like Jehu, travelling. . . . ."

and then goes on to enumerate the varied types from the Eiffel Tower vertical to the horizontal Corliss covering half an acre of floor, all of which are some day to be eclipsed by the turbine. The turbine is to supersede all the beauties and the virtues of the "ancient honoured throng":—

"For their day is past and over—
'Tis the turbine, come to stop,
For when once you start him running
He'll continue till you drop,"

* * *

A diamond when exposed to the violet rays of light becomes fluorescent, the most brilliant diamonds giving out a clear blue fluorescence and less brilliant ones becoming violet. A yellow diamond submitted by Sir William Crookes to these rays gave out a red light, and rather to the dismay of its owners subsequently turned a dingy brown when exposed to daylight. The brownishness proved, fortunately, only a temporary effect. These experiments have suggested to Mr. Fuchs, of Chicago, the treatment of diamonds with X-rays, and he says that he is able to bleach brownish and yellow diamonds by such means. This does not exhaust his claims regarding the possibilities of the X-rays. By directing them through various metals and chemicals before they penetrate the diamond he believes that colour can be permanently imparted to the stone; and that it will be possible to reproduce thus the famous blue of the Hope diamond or the brown of a well-known diamond in the British regalia. In view of the other experiments which have been mentioned we are extremely doubtful, however, of the permanency of Mr. Fuchs's methods.

* * *

Magnets are used in some industries to separate particles of metal from other particles of flour or chaff in food stuffs. The idea is employed, for example, in attrition machines, which are used for grinding rice chaff into small particles, to be mixed with more nutritious ingredients to make cattle food. These attrition machines consist of two metal discs turning in opposite directions, being separated by one-eighth to three-sixteenths of an inch. The discs are indented to give a grinding surface, and when each is revolving at a rate of from 1,500 to 2,000 revolutions a minute, it can be seen that iron or steel particles in the light chaff, which is ground between the discs, might cause sparks, which would give rise to a destructive fire. To extract such particles, the chaff, before reaching the discs, is passed in close proximity to strong magnets, which attract any specks of metal with sufficient force to draw them from the chaff. A similar contrivance is used in some flour mills, where it is well known that a slight spark will sometimes, in the presence of fine dust, cause a violent explosion.

* * *

M. Maneuvrier, assistant director of the Paris Research Laboratory, has devised a very ingenious way of testing, by means of a telephone, the extent to which wine has been watered. His invention depends on the altering conductivity of a liquid as water is added to it. Two vessels, one containing wine known to be pure, the other an identical quantity of the wine to be tested, are placed on an instrument outwardly resembling a pair of scales. The telephone is in contact with both liquids. If the sample of wine under observation is as pure as the standard used for comparison, no sound is heard. If, on the contrary, one vessel contains adulterated wine, the sensitiveness of the telephone is such that a sound, easily to be detected, is heard in it; and the greater the proportion of water, the louder the sound in the telephone. A dial, on which a number of figures are marked, is connected with the telephone. To ascertain the proportion of water in the wine tested, the operator moves a hand on the dial until the two connections of the telephone are of the same electric resistance and sound ceases. The point to which the hand has to be moved on the dial can be made to furnish data for ascertaining the exact proportion of water in the adulterated wine. M. Maneuvrier declares that his invention can be applied to the testing of many other liquids, and might even be adapted to the use of detecting adulteration of solids, when the electric resistance of the solids was altered by adulteration.

* * *

The filament in glow-lamps gradually diminishes in diameter in consequence of the slow volatilization of the carbon. According to the Elektrotechnische Rundschau, a German firm introduces into the glass globe certain chemical compounds with a high boiling point; these, under the influence of the temperature in the lamp bulb, slowly give off vapours containing carbon, which is deposited on the filament, thus making up to a large extent for the loss referred to above, and keeping the resistance and also the brightness of the lamp more uniform throughout its useful life.

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Comets and their Tails.

BY MISS AGNES M. CLERKE.

THE texture of comets' tails is very peculiar. They seem to be made up of separate threads as fine as spun glass. This is shown pre-eminently well in photographs. An emanation, that to the eye appears

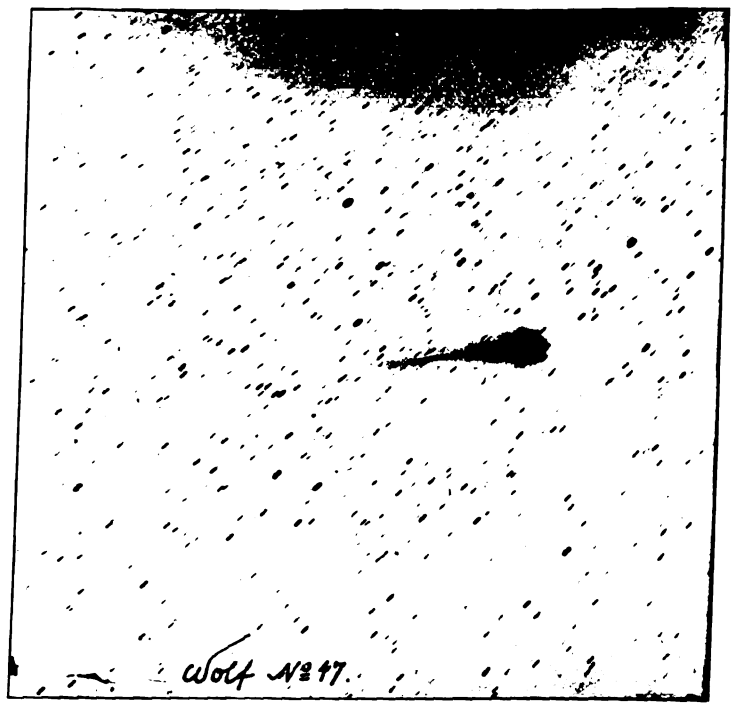

Fig. 1.—Swift's Comet. Photographed with six-inch Voigtlander lens, by Dr. Max Wolf, May 26, 1892. Exposure, 1 hr. 50 min.

a soft haze, is often resolved on chemical plates into an aggregation of luminous fibres. The effect is clearly defined in Fig. 1, which reproduces an impression of Swift's comet, obtained by Dr. Max Wolf in two hours, less ten minutes, on May 26, 1892. Though at no time conspicuous, the object was easily visible to the naked eye, and a thin, straight tail was traceable to about 12° from the head. The spectrum was, it might be said, purely gaseous; the usual carbon-bands stood out against a nearly dark background. Now the tail can be perceived

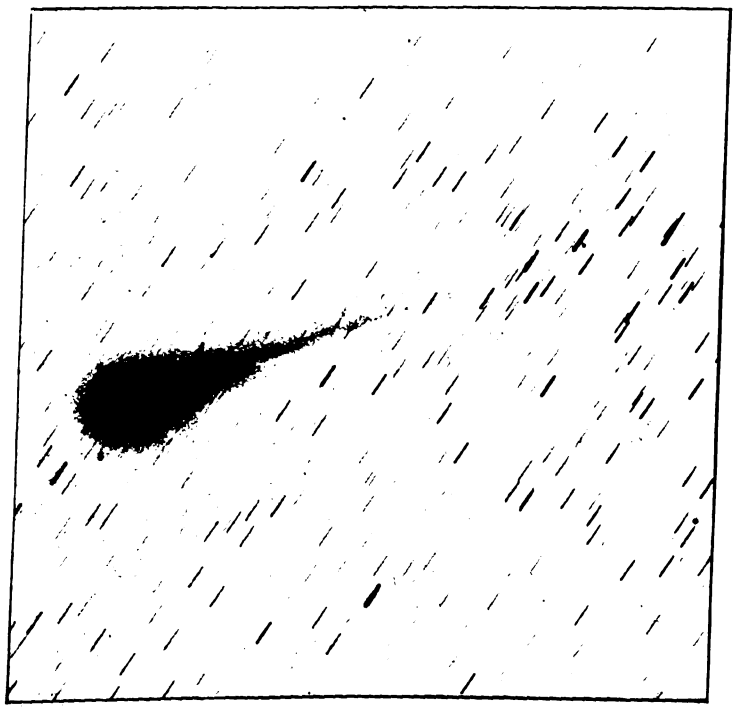

Fig. 2.—Comet Perrine. Photographed by Dr. Max Wolf, with 16-inch Bruce lens, Oct. 25, 1902. Exposure, 1 hr. 20 min.

in the photograph to be almost indefinitely subdivided. It consists of hairs of various lengths, finely drawn out. And the same peculiarity distinguishes the solar prominences and corona, and is, to some extent, present in nebulæ. Wherever, in short, there is reason to suspect the action of repulsive forces, a filamentous structure in the bodies acted upon emerges to view.

In comets, above all, anti-gravitational effects are glaringly evident. How should they be accounted for? The temptation is strong, at the present juncture, to turn to radio-activity for an explanation of whatever transcends ordinary experience; but here that facile course of thought is barred. For comets are quiescent when left to themselves; their plumage develops only with approach to the sun; while atomic disintegration (if radio-activity may be thus defined), progresses almost independently of external circumstances. Choice has then virtually to be made between two theories, both looking to the sun as the prime mover in cometary disturbances. Both, besides, are based upon the principle of the increasing efficacy of surface-action over mass-action with the reduction in size of spherical particles. Moreover, both, while explaining much, leave much to be explained away. The first is the electrical hypothesis, advocated by Olbers in 1812, and authenticated by Bredikhine's discussion of Coggia's comet of 1874. It has strong recommendations. The "three types" of appendage it distinguishes are visibly conformed to by "crystal tresses" of the "ray," "scimetar," and "brush" forms, and their interpretation, as resulting from diversity of chemical composition, seemed plausible, and engaged a ready assent. Nevertheless, Bredikhine's views still lack decisive confirmation. They require the sun and the repelled cometary molecules to be charged with electricity of the same sign, and no valid reason can be alleged why this should be so. Nor has the spectroscope spoken decisively in their favour. Hydrogen-tails remain purely speculative. Straight and curved appendages seem to be of identical composition.

An alternative theory came to hand just when it was wanted. Already, in 1619, Kepler opined that solar radiations formed lucid paths in space out of materials carried off from the cometary globes they penetrated, and Clerk Maxwell concluded for the reality of light-pressure, and assigned to it a definite value. Many years passed before experiments delicate enough for the verification of his theory became

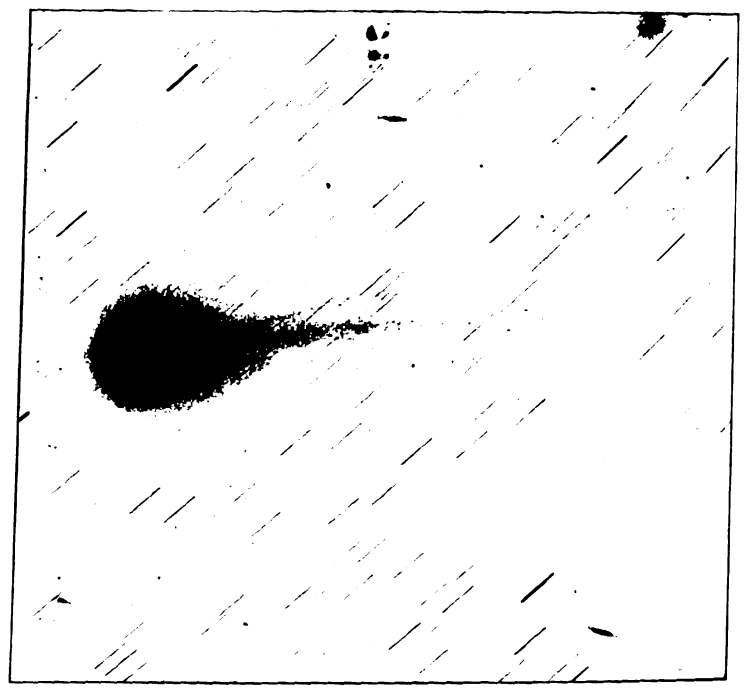

Fig. 3.—Comet Borrelly. Photographed by Dr. Max Wolf, with 16-inch Bruce Lens, July 25, 1903. Exposure, 1 hr.

practicable; but the feat was successfully accomplished by Lebedew at Moscow in 1900, and independently by Nichols and Hull in New Jersey in 1901. The sun does then exert a true repulsive power by the sole virtue of its copious emissions; and the discovery inevitably prompted a reversion to Kepler's hypothesis of comets' tails. A *caveat* was, however, entered by Schwarzschild's demonstration that light-pressure acts only on particles of a size varying with the wave-length of the impinging ray. They must, to show the effect, have diameters not greater than two and a half times, not less than one-eighth the wave-length in question. Individual molecules are far too small to be subject to ethereal impulsion; hence, matter in the gaseous state cannot, by this means, be repelled by the sun. The spectroscope, nevertheless, asserts cometary appendages to be composed of hydro-carbon vapours, and the expedients resorted to for the reconcilement of the contradiction are far-fetched and unsatisfactory. There is a further objection adverted to by Professor Boys at Southport. To meet the requirements of the light-pressure theory, cometary trains should be made of dust. And even admitting that dust were provided of the assorted degrees of fineness needed to yield tails of the typical varieties, it should be acted on by homogeneous light, if the tails were to be kept distinct. But sunlight is not homogeneous; it consists of rays infinitely gradated in refrangibility; and infinite in number, accordingly, the streams of particles propelled by it should be. As the result, we should see, not the narrow effluences depicted by Professor Wolf's camera (see Figs. 2 and 3), but broad sectors of undiscriminated haze, the like of which have never yet been seen as cometary adjuncts.

It is worth notice that "great comets" frequently exhibit a form of tail which minor bodies of the same class seem incapable of generating. This is the "hollow cone," ensuing, in the old view, upon the exercise

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of a two-fold repulsion, by the cometary nucleus itself and by the sun respectively. The paraboloidal appendage of the lovely apparition which looked down on the South African battle-fields in May, 1901, was characteristic of the portent class of object. It is depicted in

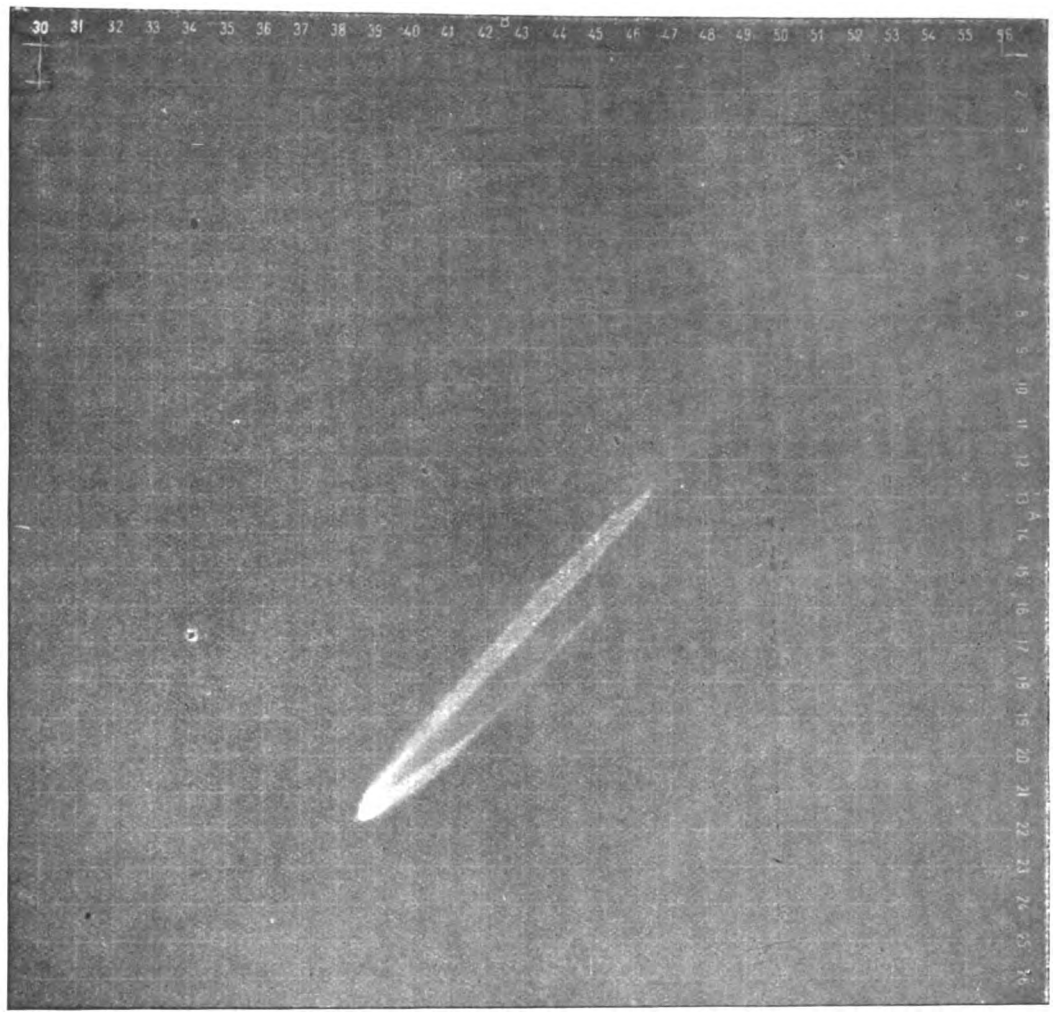

Fig. 4.—The South African Comet of May, 1901. From a Photograph taken at the Royal Observatory, Cape of Good Hope.

Fig. 4, from a photograph taken at the Royal Observatory, Cape of Good Hope; and it makes an instructive contrast with the tail of comet Perrine (see Fig. 5), which proceeds directly, and (so to speak),

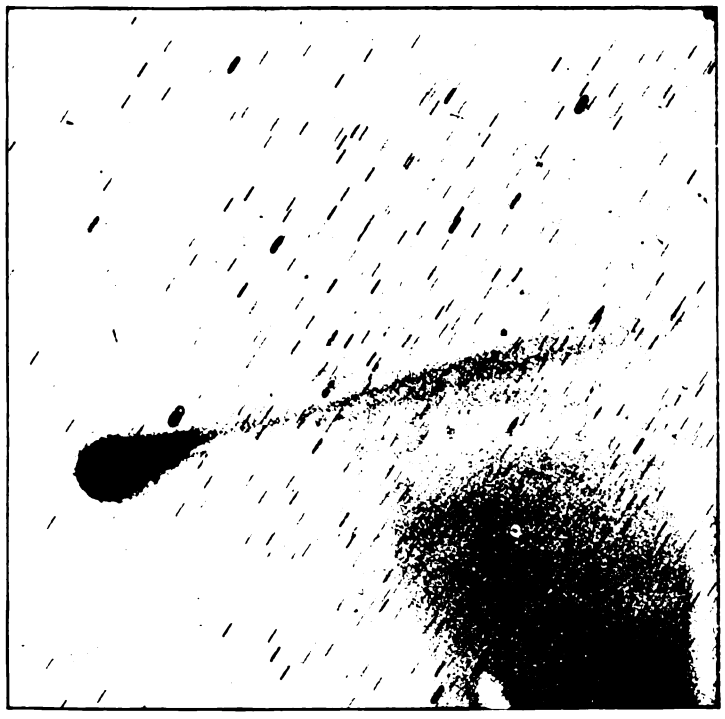

Fig. 5.—Comet Perrine. Photographed by Dr. Max Wolf, Oct. 23, 1902, with 16-inch Bruce lens. Exposure 45 mins.

without circumlocution, from the back of the head. The inference is at least suggested that the brilliant comet was opaque to the repulsive influence which freely traversed the tenuous substance of the fainter object.

Comet Borrelly, which attracted some attention in July last, was discovered by Professor Wolf to exercise an unprecedented selective action upon the rays of the stars shining through it. Figure 6 shows the nearly complete absorption of the trail marking the relative motion, during the hour of exposure, of a 6.7 magnitude star close to the comet's nucleus. Moreover, the astronomer states that the faint streak which survived absorption was entirely due to the stellar rays comprised in the spectrum between the hydrogen-lines F and G. The trail of the much brighter star, involved in the outlying part of the

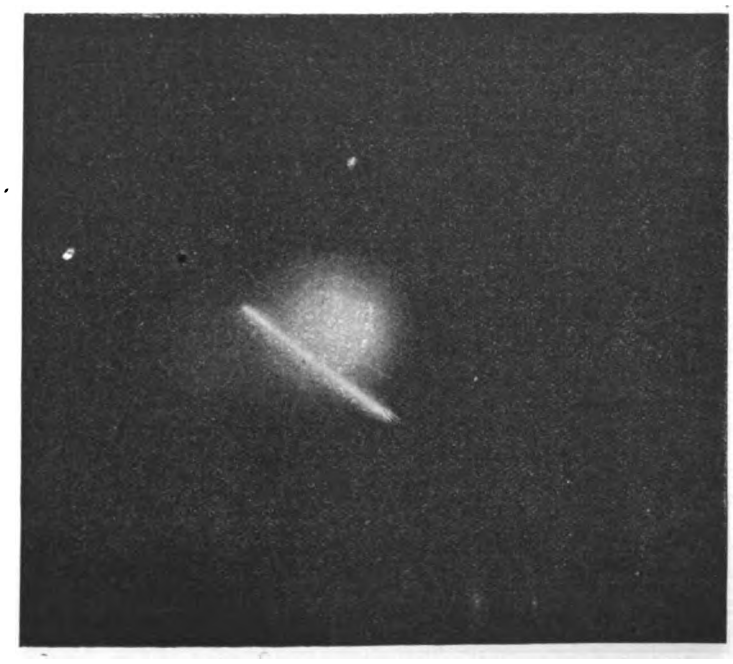

Fig. 6.—Photograph taken by Dr. Max Wolf, July 25, 1903, showing absorption by Comet Borrelly of the trail of a 6.7 magnitude star. Exposure 1 hr.

coma, has been scarcely affected by its intervention. Comet Perrine, on the other hand, behaved in a virtually neutral manner towards light, so that these two objects, though very similar in aspect, must have differed significantly in constitution.

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The Limits of Microscopic Vision.

By G. H. BRYAN, Sc.D., F.R.S.

Part I.—Introduction.

SHALL we ever be able to see molecules through a microscope?

There is a certain fascination about questions of this kind, and interest in them has lately been roused by Dr. Siedentopf's experiments, in which so-called "ultra microscopical" particles have been rendered visible, as stated in the ILLUSTRATED SCIENTIFIC NEWS for August.

In regard to the vision of actual molecules it is sufficient for our present purpose to refer to the high velocities with which molecules are commonly moving. As an example of these velocities we may instance that even at the low temperature of 66°C. the "velocity of mean square" of hydrogen molecules is 1603 metres per second. With a magnification of 1,000 diameters (such as is obtainable with existing microscopes), such a velocity would be increased to 1,603 kilometres, or 1,000 miles per second. To reduce the velocity of the molecules, the temperature must be reduced. The result of this will be to liquefy and ultimately solidify all the permanent gases, and the question then reduces to the vision of molecules far more closely crowded together than they exist in our atmosphere, although we may take the degree of closeness of gaseous molecules as indicated by the statement that ordinary atmospheric air contains some ten thousand million billion molecules per cubic centimetre. Employing this figure, a cube each of whose sides measured a ten-millionth part of a centimetre in length, would, on an average, contain one molecule, so that even were the difficulty of the molecular velocity overcome, we should still have the difficulty of rendering visible objects whose distance apart was comparable with the ten-millionth of a centimetre. This would involve a

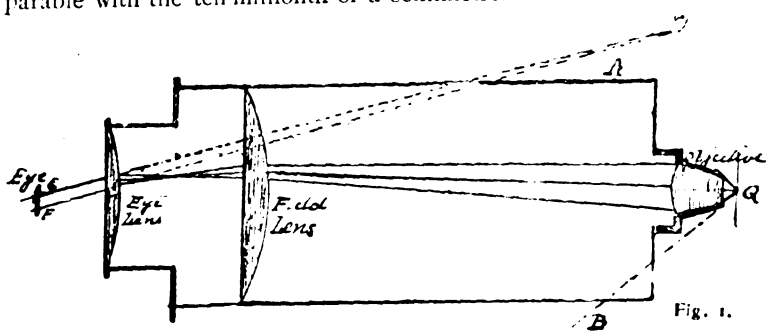

Fig. 1.

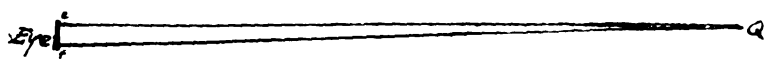

Fig. 2.

Figs. 1 and 2 show the use of a microscope in rendering particles visible when their luminosity is small. In figure 1 all the light which leaves a particle at Q within the large cone A Q B is concentrated into the pencil E q F and made to enter the eye.

In figure 2 the only light from the particle at Q which enters the eye is that included in the small cone e Q f.

magnification of some million diameters, and this, again, would magnify one millionfold the velocities of the molecules themselves. With these few remarks it only remains to leave all further discussion regarding vision of actual molecules to such speculative writers as Mr. H. G. Wells.

But setting aside such purely sensational questions, a real and practical interest attaches to the problem of fixing limits to the possibilities of microscopic vision, and of devising methods of pushing these limits as far back as possible. That this problem is not one of purely academical interest is abundantly proved by our experience in the past. It was largely due to the time spent (or, as some people at first supposed, *wasted*) by microscopists in resolving the markings on diatoms that improvements were made in the microscope, which, in turn, led to the development of bacteriology. Even stopping short of molecules it may be quite possible (failing any proofs to the contrary) that objects may exist smaller than any hitherto seen with the microscope, which may be capable of influencing some phenomena of every day life in no less a degree than do bacilli.

The first point to be noticed is that there is no limit to the smallness of an isolated object that may be visible, provided that:—

(1) The object emits *light of sufficient intensity* to render it visible.

(2) The *distance* between the object and neighbouring objects is not so small as to be beyond the limits of vision.

(3) The image seen represents only the *position* of the object, and affords no indication of its form, structure, and dimensions.

In illustration we may take the dust particles commonly floating in air. When a beam of sunshine illuminates them in a dark room, the actual particles are individually visible, provided that they are not too close together, although they are far too small to be discernible as objects of finite dimensions. Again, stars are visible as bright points of light even without a telescope, although the most powerful telescopes fail to render their size and shape visible.

In fact, even if light emanates from a mere mathematical *point* the principles of optics enable us to construct the image of that point after any number of reflections or refractions, and this image will be visible if the light radiating from the point is of sufficient intensity. The use of lenses in rendering such a point visible will be not to make it look larger, but to increase the breadth of the pencil of light by which it is rendered visible. This is shown by Fig. 1, which represents diagrammatically the passage of a pencil of light through a microscope, and it will be seen that all the rays emanating from Q within the cone A Q B are made to enter the eye; without a microscope the only rays which would reach the eye would be those included in the cone e Q f subtended at Q by the diameter of the pupil of the eye. (Fig. 2.)

If we adopt the wave theory of light we may compare the case of an object of dimensions small compared with the wave length of light with that of a body of small size in the middle of the sea. If a train of waves is flowing past such a body the waves will very soon unite after passing it, so that little trace of the effect of the body will be left on the wave-front; but the body will cause ripples to radiate from it in all directions, and these may, in the case of light, render an object visible if it is illuminated by a sufficiently powerful beam of light *at right angles* to the microscope axis, even though it could not be seen with ordinary transmitted light. This is the principle adopted in Dr. Siedentopf's experiments.

If the powers of the microscope are not limited in the matter of merely rendering isolated particles visible, limitations arise as soon as it is required to ascertain the *form* of minute bodies, or the *details* of fine structures, or to show, as *separate* objects, two particles at a very small distance apart. The optical theories, which fix these *limits* of microscopic vision (properly so-called), have formed the subject of elaborate investigations in the hands of von Helmholtz, Lord Rayleigh, Professor Abbe, Dr. Johnstone Stoney, and others. These theories are discussed at considerable length in the *Journal* of the Royal Microscopical Society for August, where, in addition to the writers already named, Mr. J. W. Gordon, Professor Everett, Dr. Czapski, Dr. Drysdale, and Mr. Rheinberg contribute interesting remarks. The whole existing literature on the theory of microscopical vision is, however, intimately bound up with mathematical reasoning. The object of these papers is to explain the theory as far as it can be explained without the use of mathematics. Let us first ask ourselves the questions:—If a microscope can be constructed giving a magnification of 1,000 diameters, and producing a perfect image of this magnification, say, 10 inches in front of the eyepiece (as in a projection microscope), why should not two such microscopes placed one in front of the other be employed (1) to give an amplification of 1,000,000 diameters, and (2) to, therefore, render objects visible which are 1,000 times smaller than those visible with a single microscope?

The answers are:—(1) That the combination *would* theoretically give the magnification of a million diameters, but (2), on the wave theory of light, it would be impossible to obtain *distinct images* of objects smaller than can be resolved by existing microscopes, as we shall now explain with the aid of Fig. (3). In all practical instruments, the image produced by a system of lenses is not a perfect image owing to various effects known as spherical aberration, chromatic aberration, distortion, and so forth. We shall, however, assume, for the sake of argument, that the microscope is optically perfect, so that all rays emanating from a point on the object converge to an absolutely mathematical point in the image, and under these circumstances it might naturally be supposed that the use of two microscopes placed tandem might give an affirmative answer to question (2).

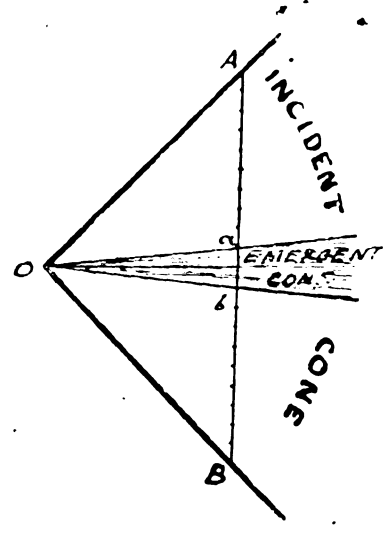

Fig. 3.

Fig. 3 illustrates Helmholtz's formula as applied to an optical instrument giving a linear magnification of 10 diameters. If A O B represents the direction of the cone of light emanating from the object which is received on the front lens of the instrument, this light will, on emergence, be concentrated into a cone (a O b), whose diameter at the section A B will only be one-tenth of the corresponding diameter of the incident cone.

But Fig. (1) shows that the comparatively broad cone of light emanating from the object is reduced to a very narrow pencil when it emerges from the eye-piece of the first microscope. If we imagine the

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breadths of the cones in question to be measured by the semi-diameters of their sections at unit distance from the vertices (Fig. 3)—(in mathematical language, by the tangents of their semi-vertical angles), Helmholtz has shown that the breadth of the cone is inversely proportional to the magnifying power (assuming the initial and final media to be the same, so that if the final image is found in air the object must be "mounted dry").

Thus, with a magnification of 1,000 diameters, the emergent cone is only one-thousandth of the breadth of the initial cone. If this small cone be received on the second microscope it will produce, on emergence, cones one thousand times as small again.

Now, a distinct image can only be produced by the convergence of a pencil of light of appreciable breadth. If, following the old geometrical theory, we regard the image as found by the intersection of different *rays*, represented by straight lines, we shall soon see, when we try to draw the lines representing the extreme rays, that if the angle between them is very small their point of intersection is ill defined. Still, this objection would not hold good in the case of two ideal

Fig. 4.

Fig. 4 shows that in the case of a very narrow pencil of rays the position of the vertex of the pencil (or focus) is ill defined.

It is difficult to fix the exact point of intersection of the pair of crossing lines drawn on the paper.

mathematical straight lines defined as "having length without breadth," and it may be fairly safe to say that if light consisted (as was formerly supposed) of rays travelling in mathematical straight lines, and if it were possible to construct perfect lenses devoid of aberration, we must admit that there would be no theoretical limit to the smallness of structures the details of which could be shown by means of a microscope.

But light is really produced by waves, and it is physically impossible that a wave motion should exist in the interior of a pencil of limited extent without producing subsidiary disturbances in the medium outside that pencil. If the breadth of the pencil is large compared with the wave length of light the effects of these external disturbances are small in comparison with those of the waves inside the pencil, so that the geometrical theory practically accounts for all the phenomena actually visible to the eye. But in the case of a very narrow pencil, whose breadth is comparable with the wave-length of light, the subsidiary disturbances become important and give rise to diffraction phenomena, which may completely alter the character of the observed effects. It accordingly becomes necessary to study the nature and character of diffraction before proceeding further on our enquiry.

Continental Physical Notes.

By Dr. ALFRED GRADENWITZ.

Further Facts About Ultra-Microscopical Particles.

IN a paper read before the Cassel Meeting of the Congress of German Naturalists, E. Raehlmann gives some further particulars on the ultra-microscopical investigation of mixtures of dyeing-stuffs and their physico-physiological significance. These experiments were made by means of the Siedentopf and Zsigmondy microscope, described in this paper (Vol. I., No. 11, p. 185). This microscope enables the dye-stuff particles to be seen up to dimensions as small as 1 to 10 $\mu\mu$, in solutions of Prussian blue and naphthol yellow. The smallest particles of Prussian blue show a violet-red, and those of natural yellow a brass yellow colour; they are shown *continually* to perform movements, seemingly characteristic of each dyeing stuff. These movements, in the case of such particles as are capable of polarising light, being inferior to 1 to 40 μ, are vibratory or pendulum movements, whereas other particles seem to describe arcs. These movements are, both as to their amplitude and form, dependent on the relative magnitude of the particles as well as on the substance itself, appearing to be different in both respects for different concentration of the solution, as to be influenced by the mutual distances of the particles.

The author is at a loss to ascertain to which forces these movements are due, and which is their connection with the brown molecular movements, though the distribution of the dye stuff particles in the aqueous solution, the character of the movement as well as its dependence on the mass of the particles, are instances of mutual attractions and repulsions of the particles being of an electromagnetical nature.

On mixing the two above dyeing stuffs, so as to obtain a mixture of a distinct and intensive green colour, the particles detected by the Siedentopf and Zsigmondy miscroscope are found to be wholly different, those of Prussian blue being now yellowish red, and those of naphthol yellow intensely green. As regards the movements of the particles, there does not appear to be any difference from those observed in the unmixed solutions.

These experiments show a physiological mixture of colours from infinitely small light components to take place in the eye. These alterations in the colour of the single molecular parts of each dyeing stuff are shown by spectroscopical investigation to be accounted for on the hypothesis of a thin layer of the other dyeing stuff surrounding each dyeing stuff particle. As regards the way in which this association of each particle with a surrounding layer may occur, the author thinks electromagnetical forces of the molecules to be operative. If the molecules of both of the dissolved dyeing stuffs, according to Mie's views, are electrically charged, or else constituted by ions, producing electrical forces, the process would be accounted for by ascribing to the molecules of one dye-stuff positive and to those of the other negative electrical properties, when the electric tension would be compensated by a mutual attraction. As with the new microscope only particles greater than 1 $\mu\mu$ are susceptible of being seen, there is a possibility for particles still smaller being dissolved or suspended in the water, in addition to the smallest visible particles. These smallest particles would possibly be free ions; anyhow, they are likely to travel through the water, in virtue of their electromagnetical property, and to associate themselves around the greater particles.

This alteration of the smallest particles of dye-stuffs would thus be analogous to the phenomena responsible, according to Thomson and Townsend, for the formation of clouds and fogs, small drops associating around the dust particles present in the air.

According to the above, the new microscope seems to be likely to elucidate many physico-chemical phenomena.

The Jungner-Edison Accumulator.

On account of the more or less mysterious particulars given in connection with his new accumulator, likely in Mr. Edison's opinion to revolutionise the field of electric traction by accumulators, Mr. U. Schoop, in a recent issue of the *Electrocech-Zeitschr.*, records the results of a comparative investigation of the familiar lead-plate storage battery and the Edison alkalic accumulator, this investigation being the more interesting as the Edison battery had not yet been brought out. Dr. Jungner, a Swedish chemist, has, as is known, at the same time and even most likely before Mr. Edison, patented a similar galvanic combination, based on the fact that nickel oxide, conveniently fixed on a support, will constitute an excellent depolariser. Whereas for transportation purposes the lead accumulator in its present form shows many drawbacks, its considerable weight being one of the most serious, stationary lead accumulators, where both weight and space do not play but a secondary part, have reached such a degree of perfection that no other type of storage battery is required in the latter case.

Although the comparison between the lead and alkali accumulators be not complete, nickel and steel plates coated with nickel appear in alkalic solutions not to be altered by the currents to which they are exposed, even after weeks; there are, in fact, never observed any corrosive effects as in the case of lead peroxide plates. The author thinks it, however, possible that the active masses, present in perforated cells in the form of compressed powders, and seemingly devoid of the adhesive properties of lead, should drop from their supports after a more or less prolonged operation. He thinks that a diminution in capacity should be avoided by heating the electrode. An alkali cell was finally inserted in a charging and discharging device, allowing of 200 to 300 charges and discharges being effected in the course of one month. The details relative to these experiments are to be published later on. As to the durability of lead accumulators, even in the best storage battery, the positive lead support is known to be gradually destroyed by oxidation, whereas the negative mass progressively diminishes in capacity. The requirement of a satisfactory durability is therefore in absolute disaccord with the requirements of a small weight. On the other hand, the tables recording the experiments of the author show the alkali storage battery, though possessing evident advantages, to exhibit for the moment being an equally great number of important drawbacks. Mr. Schoop thinks, however, this type of accumulator quite as susceptible of further improvements as was in its earliest stages the lead accumulator, so that all these drawbacks might gradually be eliminated.

The Problem of the Mutual Influence of Cathode Rays.

In a note read before the recent Congress of German Naturalists, F. Neesen attempts to show that the absence of a mutual influence of different cathode rays does not depend on an electro-dynamical back effect. Two cathode rays from independent discharges were led one along another in opposite directions and immediately beside each other, in the same tube, when no effect was observed, though the electro-dynamical influence should aid the electrostatical effect.

"Ionoplastics," A Complement to Galvanoplastics.

In exhausted tubes, where glow discharges take place, the walls, as is known, will gradually take a coating of disengaged electrode particles. This phenomenon is utilized by Mr. L. Houllevigue to obtain metal films. The stream of small particles given off by the cathode will form a metal deposit on a support either conductive or non-conductive, the case of films on glass being the most interesting.

The apparatus used by the author, as pointed out in a paper recently read before the French Physical Society, consists in a glass bulb placed on a conductive plate; the latter is connected to the

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positive pole, and bears an aluminium disc on which the glass plate to be treated is placed. The cathode terminates in a plate of the metal to be precipitated, placed above the glass plate. The current is supplied from a Ducretet induction coil, though the same results are likely to be obtained with any other transformer.

The plate to be coated with metal should be placed about 15 mm. below the cathode plate. After obtaining a vacuum of about $\frac{1}{20}$ to $\frac{1}{100}$ mm., the induction coil is allowed to work, when the glow discharge will fill the whole of the bulb, and the cathode be surrounded by the well-known Hittorff dark space. After the cathode is freed from the gases occluded, a stream of projected metal particles is started, most of the particles being precipitated on the glass plate in front, where a coating is rapidly formed, while the whole of the bulb is heated. If the film is supposed to have taken a sufficient thickness, the process is discontinued, and after cooling and allowing the air to enter again, the plate coated with metal is taken off the apparatus.

The film thus obtained is more or less transparent or opaque, according to the time of working; it is perfectly reflecting, and in proportion with its small thickness, rather resistant. Most metals will, on transmission, show brown colourations; copper takes a distinctly green colour, gold is greenish blue, and silver violet. In incident light, however, they will, especially on the side of the glass, show the well-known irisation phenomena of thin films.

The metal films obtained by this process show a singular behaviour in many respects. Thin bismuth layers are, for instance, found to be insensible with regard to the action of the magnetic field, their resistance remaining unaltered. Hence it is inferred that such bismuth is amorphous. On the other hand, the author succeeds in showing the presence of a magnetic rotation in the case of transparent iron films.

The above process is likely to become a useful complement to galvanoplastics, being especially available for obtaining mirrors and other parts used with scientific instruments; the author therefore terms his process "*ionoplastics*."

Spectroscopical Determination of the Atomic Weight.

It has been known for some time that there are some connections between the line spectrum of the elements and their atomic weights; this is shown for instance by a comparison of the spectra of alkali metals, when the lines are found to approach towards the red of the spectrum for increasing atomic weights.

These relations form the subject of a paper by C. Runge, read before the recent Congress of German Naturalists, held in Cassel on September 20-26, 1903. On closer investigation it is shown that each line of one element will correspond with a given line of another element, the structure of each spectrum thus being perfectly regular. When combining the lines by groups in so-called series, the same image is obtained for each element, any two images corresponding with one another point per point. This mutual connection of the spectra, it is true, has not so far been possible for any groups of chemical elements. Wherever series were found, as for instance with Mg Ca Sr, Zn Cd Hg, Al In Tl, Cu Ag Au, the series lines at least may be connected with one another. As regards the numerous remaining lines impossible of being arranged in series, other criteria have to be resorted to, in order to arrive at a connection from one element to another. Similar criteria are afforded: (1) by the aspect and behaviour of the lines, which may be easily reversible, enlarged or well defined, the variation of the wave length under the influence of varying pressures, the luminous intensity at different temperatures in the Bunsen burner, the electric arc, the spark, in the case of self-inductions being inserted, &c.; (2) the law of constant vibration differences; (3) the behaviour of the line in the magnetic field. Out of these different points, the behaviour in the magnetic field is especially adapted for establishing the mutual connection of spectral lines.

If the different corresponding lines of a group of elements are found, the periods are a simple function of the square of the atomic weight, it being possible to determine either graphically or by the means of empirical formulæ the atomic weight of an element from the atomic weights of related elements.

If the analytical form of this function were known, this method would afford a very accurate means of determining atomic weights. For the corresponding line pairs of constant vibration differences, an empirical formula may be established, representing with a high degree of accuracy the distance of the lines of a pair in terms of the atomic weight. This distance, within a group of chemically related elements, is, in fact, proportional to a certain power of the atomic weight, the logarithms thus being lineal functions of one another. The above law has been applied by the author, with the assistance of Mr. Precht, to a determination of the atomic weight of *radium* when the strongest radium lines were found to form pairs with constant distances. The lines, as shown by the author, will correspond according to the Zeeman effect with certain pairs in the spectra of Mg Ca Sr Ba., the distance of the two lines of a pair increasing from one element to another along with the atomic weight. When plotting the distance in terms of the atomic weight, the value of the atomic weight of radium, as found by extrapolation, is 257, whereas Mme. Curie gives 225. The author thinks the substance used by the latter experimenter to have contained some barium, which would account for the high departures stated.

Chemical Reactions at Extremely High Temperatures.

In the Goldschmidt thermite process, as pointed out in our last issue, temperatures as high as about 3000° are obtained by indirect combustion of aluminium by means of *bound* oxygen. Now the combustion of the same element in *free* oxygen should give rise to much higher temperatures, the figures given by theory being in the first case about 5117° and in the latter case 19,062°.

This was undertaken lately by Professor C. Zenghelis (see *Elektrochem Zeitschr*, No. 5), by pouring aluminium powder gradually into a highly heated melting crucible, when it burned with a whistling noise on a strong stream of oxygen being led through it. The temperature reached by this means was at least as high as in the electric arc, as may be inferred from the results obtained, which may be summarized as follows:—

Platinum, chalk, and magnesia would be instantly melted and vaporized, a great part of the chalk and magnesia combining to form aluminate. The crucible was, after some grams of aluminium were burned, found to be molten at one point and eventually was pierced. The unburned aluminium remaining in excess took the form of a sphere, the hardness of which was throughout as high as 7½ to 8; most of the oxygen had been converted into ozone. By burning a mixture of aluminium with 15 per cent. of graphite powder in oxygen, aluminium carbide was formed. Similarly, by replacing the oxygen stream after an extremely high temperature had been reached, by a stream of nitrogen, the nitrogen was found to combine with aluminium, forming a nitride; 38·57 per cent. of the aluminium used could thus be converted into nitride.

Aluminium, at temperatures above 1000°, undergoes both in carbon dioxide and monoxide a most lively combustion, no trace of carbon being left, the combustion occurring readily and resulting in the formation of aluminium oxide and carbide. A similar behaviour was observed with regard to N_2O and NO, reacting violently with aluminium at this temperature, when aluminium nitride and oxide were formed.

Powellized Wood.

A New Process of Strengthening and Preserving Timber.

CONSIDERING the vast quantities of comparatively useless timber that abounds in forests in many parts of the world, useless because it is so light, porous, and brittle, any method of rendering this harder and stronger should be of the greatest importance in widening our source of timber supply. Such a process has recently been brought forward by Mr. William Powell, of Liverpool. Put shortly, it consists of boiling the timber in a saccharine solution, then leaving it to cool and so absorb the syrup into its cells, and afterwards evaporating the moisture in a drying chamber. The interstices of the wood are thus filled with a substance akin to the wood itself, rendering it more solid, firm, and compact. The dried sap of the sugar-cane acts in timber much as mortar does in a stone wall, it binds the materials strongly together.

Timber thus prepared will stand high temperatures with impunity, it is increased in strength, durability, and elasticity, and thus the wood may be seasoned rapidly, without cracking or splitting. Indeed, cracks in seasoned timber become actually closed, if clean and not too wide, when thus treated. Some tests have recently been made at Messrs. Burt, Boulton, and Haywood's works with Powellized wood, which show, among many others, the following remarkable results:—

Pitch pine increased in strength from	14	to	32 per cent.
White pine	,,	,,	29 to 39 ,,
Yellow pine	,,	,,	56 to 107 ,,

It might be thought that when immersed in water the sugar would dissolve out, but this is not the case, the porosity is lessened and the wood is rendered almost impervious to water. Another advantage claimed for the process is that it checks the tendency to dry rot, and also renders the wood less liable to the penetration of disease germs, and, therefore, makes it more hygienic.

As regards inflammability, here, again, an advantage is claimed for the processed wood, which, being more tightly packed, does not burn so rapidly as timber in its natural state, filled with air.

When examined under the microscope no free sugar is visible, the cellulose walls of the timber cells are simply thickened by the syrup absorbed.

A great number of different kinds of wood have been treated, all with beneficial results; but it is especially with light porous woods that a great improvement can be made. Such woods as poplar, hitherto of very little use, can now be most profitably utilized.

The cost of the process is moderate. No actual figures can yet be given as to the cost of processing timber in large quantities, but it is clear that the process is very simple and easy to apply, and the chief ingredient, sugar, is very cheap. It is stated that weight for weight, the sugar used is only of about the same value as the wood (pine), while bye-products, such as molasses, which is quite suitable for the purpose, are cheaper still. Here is a chance for the poor sugar planters of the West Indies!

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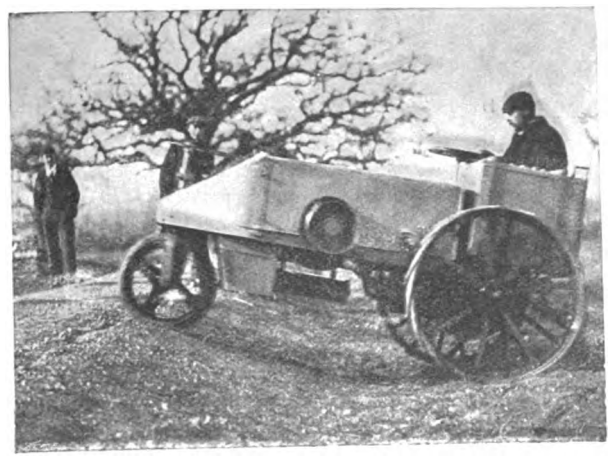
The Motor in Agriculture.

IT has been anticipated by those who have studied the capabilities of motors that in another ten or twenty years the horse will have been superseded for purposes of traction in towns and along roads, and will be relegated to agriculture and sport. The horse's place in sport one may regard as established for many generations to come, but even in agriculture the advance of the motor has shaken its certainty. The appearance of a motor on the farm is still more or less of a novelty, but the work lately done by the Ivel Agricultural Motor seems to point to a time when much of the work for which horses are still employed in agriculture will be accomplished with greater ease, speed, and certainty, and at a less cost, by machinery. Some experiments carried out



Over Rough Ground.

by the Ivel motor with the idea of ascertaining the cost as well as the nature of the work which it is able to accomplish have been made by the company responsible for its manufacture; and the following certified results of its abilities are of sufficient general interest to warrant us in reproducing them:—

In a ploughing experiment the Ivel motor, hauling a double furrow plough, ploughed two acres 15 poles of land of very hard surface to an average depth of 7 inches in 5 hours 49 minutes, and the cost worked out at a rate of 7s. 8d. per acre, which included everything, including men's time.

Nineteen acres of wheat were cut in 10 hours at a cost of 1s. 9d. per acre. This, of course, is much lighter work, and the machine was able to travel much faster.

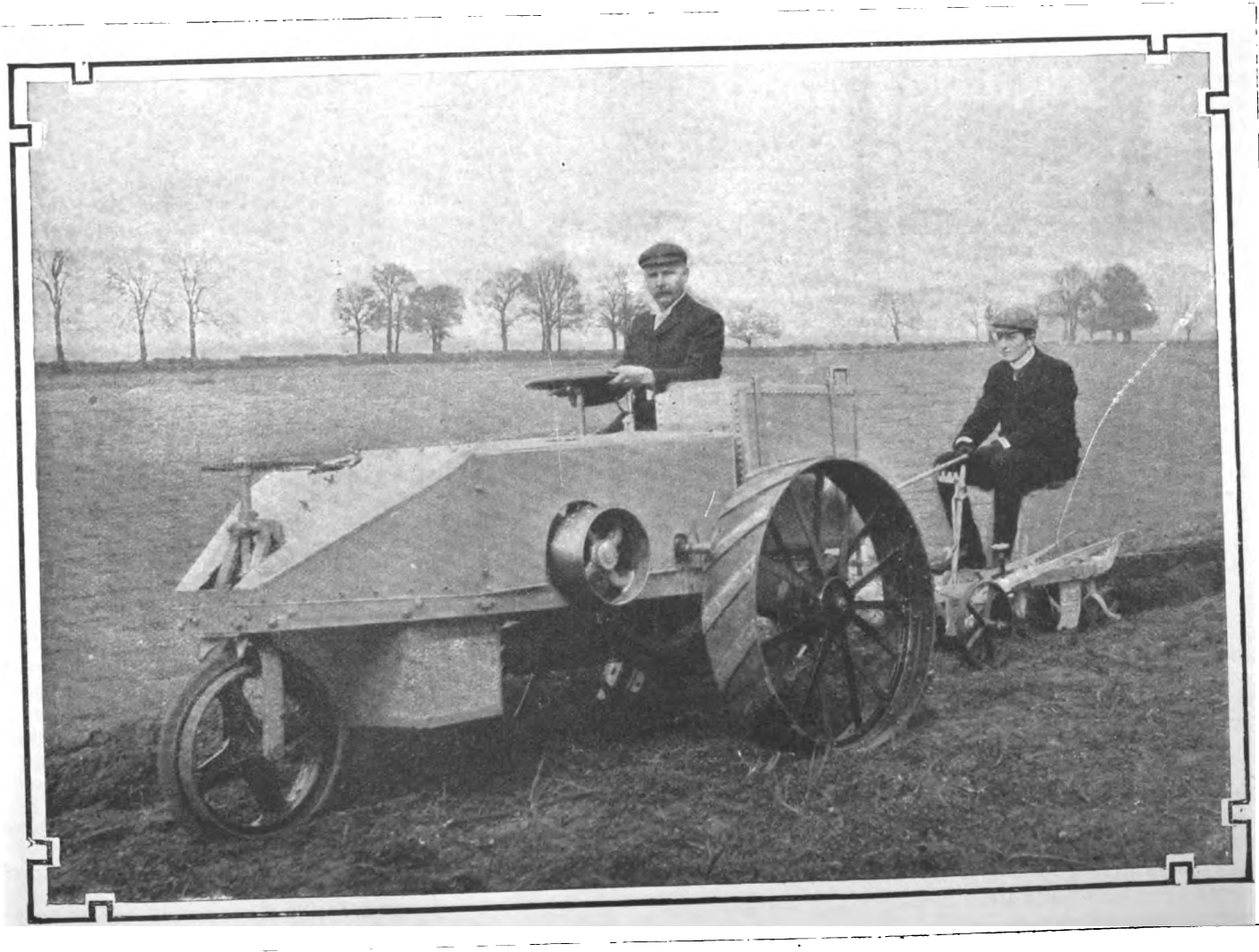
Nine acres of grass were cut in 5 hours 13 mins. at a cost of 1s. 9d. per acre.

Twenty-one and a half cwt. of chaff was cut to a gauge of $\frac{3}{8}$ in. in 47 mins. at a cost of 2s. 6d.

Back View.

The weight of the machine has been a matter of careful consideration, and all machines are to have a standard weight of 28 cwt., which is sufficiently heavy for proper adhesion to be obtained on the road wheels for heavy work, and at the same time sufficiently light as to make hardly any impression on the land.

Among the possibilities of the motor is its ability to haul any kind of double furrow plough, scuffle, reaper and binder, mowing machine, or, in fact, any agricultural implement. No special fittings are necessary. In addition to this, when the motor is not in use it can be doing carting work. It can also be used for stationary engine purposes, such as driving threshing machines, chaff cutters, pump, dynamo, etc.



The Ivel Agricultural Motor Ploughing.

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The Natural History of British Wild Plants

By J. C. SHENSTONE, F.L.S.

III.

A MOST interesting branch of this subject is the "distribution of species." The most important influence regulating the distribution of species is the climate. The arctic, the temperate, the subtropical and the tropical zones each having their characteristic flora. Another important influence is that of altitude. As we mount higher upon mountain slopes, we find what are known as alpine plants gradually replacing those of lower levels.

The geological formation of the soil has also an important influence upon the flora. In our flora we find plants described as growing upon chalky soils and upon sand and gravel. Upon river banks and in wet meadows and bogs, in woods and waste places, and in hedges and cultivated fields, upon rocks and walls, on sandy sea-shores, and upon salt marshes. In fact, if a traveller collected plants as he proceeded on his journey, a botanist could describe to him much of the natural features and geology of the country he passed through. Some plants require an abundance of chalk, no doubt to assist in the chemical and molecular changes accompanying the development of the plant. Other plants require other chemical and physical conditions, their cellular and external structure being also modified to suit these conditions. When fresh conditions arise, new plants appear, carried by birds, animals, or the wind, or possibly developed from seed lying dormant in the soil. After the Great Fire of London, a plant new to the British flora sprang up on the site of the ruins in great abundance[1]. When a railway cutting is made new formations are exposed, and almost invariably new plants make their appearance. Some water plants can assume the character of land plants when the streams and ponds dry up, whilst many salt marsh plants may also be found high up on mountains, and when placed in gardens where they have not to compete with other plants thrive without the saline constituents of their salt-marsh habitats. Such plants have evidently adapted themselves to their new conditions of life more recently than those which cannot be removed from their usual environment. Man has not only domesticated many animals, such as the horse, the dog, the cat and others, but he has also cultivated many plants until their origin has become either difficult or impossible to trace. And as some wild animals, such as the rat, the mouse, and others thrive best in the neighbourhood of man, so many wild plants have adapted themselves to the conditions brought about by man in cultivating the soil. Many plants of the next group appear to have specially adapted themselves to the conditions of cultivated land, and to grow in the hedges, the meadows, and cultivated lands of our country, and man has, from quite early times, taken advantage of the fact that plants of this family are favoured by the conditions of cultivation, and has grown them as vegetables and for decorative purpose. The fact that no plant of this order is unwholesome favours their selection as vegetables.

The next family is the great

Cress Family (*Cruciferæ*),

which is, perhaps, the most natural family of plants. We have seen that, although the flowers of the Crowfoot family were all modelled upon the same basis, they varied very widely in appearance, this difference being largely due to modifications in the form of the petals, and the habit of the plants. The Cress family have all flowers similar in structure, nor does the habit of the plants differ widely. All the plants have four sepals. All have four petals, the petals, with two exceptions, being of the same shape, and arranged like a Maltese cross. The colour of the petals is, with few exceptions, of the primitive colours, yellow and white, a few being different shades of purple and mauve, showing an effort to evolve a more highly specialised colour. But the stamens are even more constant than the petals. Four of these are long and two are short, the two short stamens being very rarely absent. The fruit is also characteristic, consisting of pods. Some of these are, however, long, and some short, enabling us to divide the family into two sub-families.

No single plant of this order is poisonous, and it is one of the two or three most useful groups of plants providing us with most of our vegetables, cabbages, broccoli, cauliflowers, Brussels sprouts, turnips, radishes, seakale, watercress, mustard, garden cress, horse radish, and many others. In some cases these vegetables have been so modified by cultivation that it is uncertain from which wild plant they are derived. Many favourite garden flowers, such as the stock, the wallflower, and candytuft, are also provided for us by this family.

The Wallflower (*Cheiranthus Cheiri*)

is, perhaps, the most popular of the group, and has been so from very early times. It has also been called Chevichaunce, and many other popular names. It is the gilliflower of later writers, though the gilliflower of Chaucer and Spenser is the Clove Pink. The wallflower is said to have been introduced from Spain as the wall-stock Gillifer. The flower is alluded to in "Spenser's Shepherds' Calender,"

"The pretty paunce and the Chevisaunce."

Chevichaunce is evidently an error for "Cherisaunce," or "cheirisaunce." Cheiri is a moorish name "Keiri," brought from Spain with this plant.

The word also appears in Chaucer's "Romaunt of the Rose":

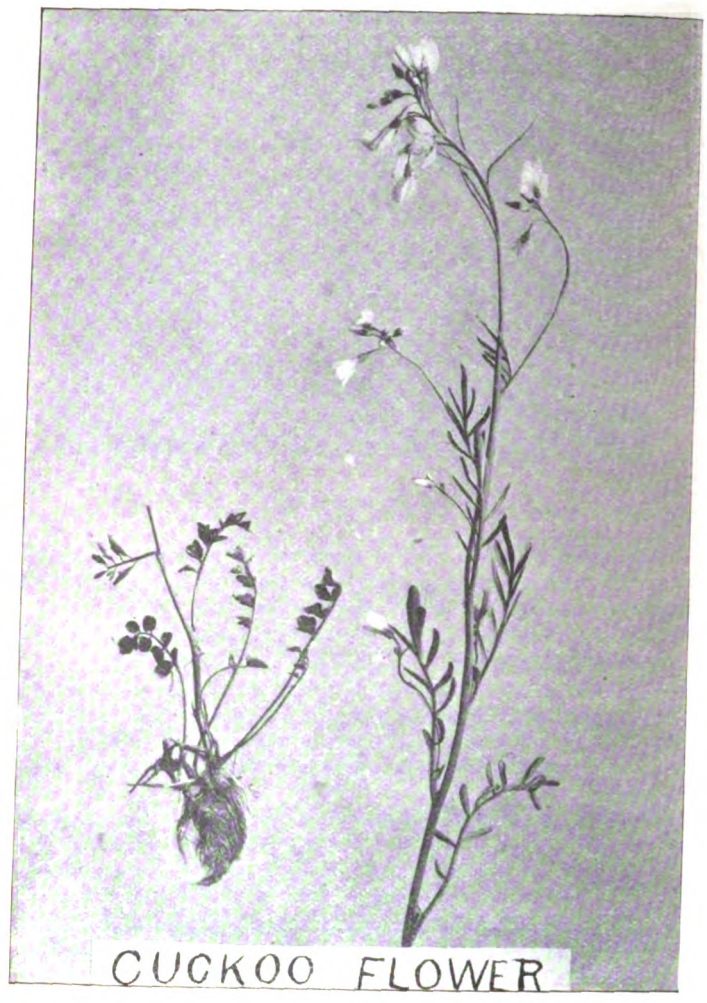
Then dismayed I left all soole,
For wearie, forwandred as a foole;
For I ne knew ne cherisaunce.

The troubadours held the wallflower in great favour, and old provincial ballads tell its praises.

Another familiar flower belonging to this family is the

Cuckoo Flower (*Cardamine pratensis, Lin.*),

also called ladies' smocks, and several other names.



Its name, "Cuckoo Flower," says Gerarde, is given to it because it flowers at Whitsuntide, "when the cuckowe doth begin to sing her pleasant notes without stammering." Some botanists derive the name from the so-called cuckoo spit found upon it. This spit is formed by an insect, and is not peculiar to the plant.

Shakespear's cuckoo flowers were probably the crowfoot or buttercup. This plant he called lady's smocks, in the quotation from "Love's Labour's Lost" already given. (See Meadow Crowfoot.)

Drayton also called this plant lady smock.

Some to grace the show
Of lady-smock most white do rob each neighbouring mead
Wherewith their loose locks most curiously they braid.

Surrounding the base of the two shorter stamens of this plant are two green fleshy cushions, which secrete honey on the outside, and two smaller glands occupying the position of aborted stamens. The honey accumulates in the pouched base of the sepals, the calyx being in this case more persistent than in most crucifers, and the two sepals which receive the honey from the large glands are more swollen than the other two. All the anthers are turned towards the pistil in the young flowers, and this projects above them; but before the flower opens, the four inner stamens elongate and overtop the stigma, making a quarter of a revolution outwards, each one towards the nearest shorter stamen. An insect trying to reach the gland must rub against the nearest anther. When, in wet weather, the revolution is not performed, the tall stamens drop their pollen on the stigma. The short stamens remain with the side at which they dehisce turned to the stigma, so that pollen is rubbed on insects making for the small glands.

The flowers droop at night, and in rainy weather. Kerner tells us that if you imitate the strain caused by rain-drops, or the vibration caused by the wind and rain, the flowers droop, and cannot be straightened for some hours without breaking them.

When the seed capsule is ripe it bursts, and its walls roll up like a corkscrew, throwing the seeds widely, thus dispersing them. Buds which have been propagated have been found upon the leaves of

1. The London Rocket (*Sysimbrium Irio, Lin.*).

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this plant, and the seed vessels have been found to contain petals in the place of seeds, giving the flowers a curious appearance.

The Hairy Bittercress *(Cardamine hirsuta)*

differs from most members of this family in having only four stamens, the two short ones being suppressed.

Whitlow Grass *(Draba verna, Lin.)*

is almost the first flower to appear in our hedges. It was formerly believed that when this little plant appeared in large quantities a short crop of corn would follow. If that is so, it would be due to a wet season, which favours this plant, being antagonistic to the corn crop.

The Water Cress *(Nasturtium officinale Br.)*

is too well known to need description. The structure of all the plants of this group being very nearly identical, it will not be necessary to describe the species at length in each case. The arrangements for cross-fertilization differ only slightly from those of the cuckoo flower already described.

The leaves of this plant have been found with buds upon them. This plant was used as a violet dye before the days of coal tar-colours. It is said to contain iodine, and therefore to have medicinal properties.

The Tower Mustard *(Arabis perfoliata, Lam.)*

has a rosette of radicle leaves, which are covered by very beautiful stellate hairs. This rosette of leaves is formed in the autumn, at the base of the erect stem, and survives the winter. They are coloured violet on the side which is turned to the ground, while the leaves which appear on the stem the following summer are green below. This violet colour is due to anthocyanine, which absorbs light and converts it into heat, and it is suggested that this property may be of value to the plant under certain conditions which do not favour the production of chlorophyl, for which it may act as a substitute.

The Scurvy Grass *(Cochlearia officinalis, Lin.)*

derived its name from its having formerly been a valued remedy for scurvy, which gave so much trouble to sailors. This plant is abundant on our salt marshes over which the tide flows; oddly enough the plant, like other sea-coast plants, occurs also high up on mountains, but not in the intermediate heights.

The London Rocket *(Sysimbrium Irio, Lin.)*

is a rare plant occurring in the neighbourhood of London. It first appeared there after the great fire of 1666, growing in great quantities on the ground laid waste.

SCURVY GRASS

The Treacle Mustard *(Erysimum cheiranthoides, Lin.)*

derived its name from its having been an ingredient in the once famous Venice treacle. This is said first to have been made by Mithridates, King of Pontus, but was included in the London Pharmacopœias until about 100 years ago. It contained no less than 72 ingredients.

The Wild Cabbage *(Brassica oleracea, Lin.)*

is the ancestor of all our cultivated cabbages, including the cabbage, the Brussels sprouts, Cauliflowers, Broccoli, also of Kohl Rabi, and of the hundred-headed cabbage.

The Brassica Napus *(Lin.)*

gives us rape or coleseed, which yield some 33 per cent of oil.

The Wild Swedish Turnip *(Brassica campestris, Lin.)*

from which the Swedish Turnip has been derived by cultivation.

The Wild Turnip *(Brassica rapa, Lin.)*

from which the turnip has been derived by cultivation.

White and Black Mustard *(B. alba, Bois, and B. nigra, Koch)*

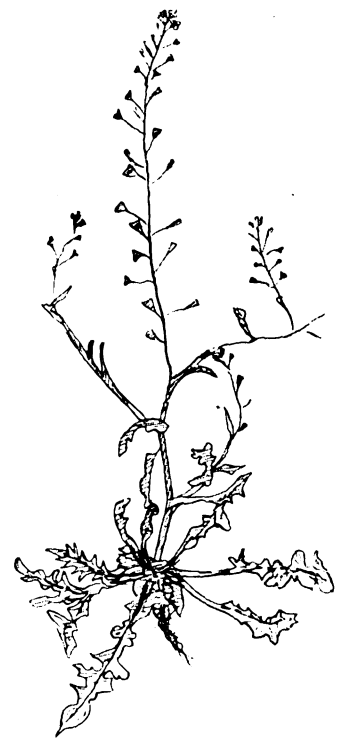
which give us the useful condiment known as mustard.

The Shepherd's Purse *(Capsella Bursa-pastoris, Moench)*

is peculiar for its triangular shaped seed vessel, so familiar to all. Its name, Clappede pouch, is a nickname derived from a clap or rattle pouch, alluding to lepers who stood in the crossways with bell and clapper to excite public generosity. The lepers got the name of rattle-pouches, which name was extended to this little plant which hangs out pouches by the wayside. The lowest leaves on this plant are much the longest, those at the top being reduced to mere scales. This arrangement secures the exposure of all the leaves to light and air.

The Dyers' Woad *(Isatis tinctoria, Lin.)*

a name derived from old Saxon "wode." This plant has from the earliest times been cultivated as a dye plant, and is still used as an ingredient in the indigo dye vats, as a ferment to render indigo



SHEPHERDS PURSE

soluble, for the better qualities of materials. It may have been used by the ancient Britons, though it is difficult to understand how it could have been utilized for staining their faces as stated by some historians.

Professor Darwin and Meldola give an account of the preparation of woad at a mill still existing at Parsons Grove. The method of preparation is very primitive. The leaves are crushed to pulp under rollers and the mass kneaded by hand into balls, and dried on gratings in a drying shed. They are afterwards ground up, and in another shed sprinkled with water, and allowed to ferment for nine weeks. The woad is then dried and sent away. An infusion, to which lime or some other alkali is added, forms the dye bath, and gives a very permanent blue colour, though not so rich in colour as indigo.

The Seakale *(Cramle maritimum, Lin.)*

was discovered by an accident by a Dr. Lettsome, who many years ago, when travelling on the South Coast, found a woman cutting kale in the sand, and found that the fishermen ate it as a vegetable. He introduced it to the celebrated nurseryman Mr. Curtis, who sold the seed to the public. The wild plant may have been used in quite early times. If you cut the stem of this plant transversely, after the pith has decayed, buds will form on the inner surface of the woody ring, and shoots develop. They may also be produced anywhere on the stem by bruising.

With this I must conclude the account of perhaps the most useful group of plants to mankind, though in consequence of the uniform structure of its species it offers less points of interest to the scientist than many of the less natural families.

Poets and the Nautilus.

POETRY has, perhaps, no place in the exact sciences, partly because exactness is incompatible with poetic licence, partly because of the unalterable tendency of the poet to get things wrong. A curious example of this was noticed in a lecture at the Camera Club by Mr. Duncan on cuttle fishes. The modern cuttle fish is a descendant of the fossil Belemnite; but the only descendant of the co-eval Ammonite is the Paper Nautilus. Better known is the Portuguese Man of War with which the Paper Nautilus is sometimes confused, but which is really allied with the Belemnite group; because while its shell appears external, it is not really so.

The poets Pope, Byron, and James Montgomery all easily fell into the error, and Pope's well-known lines in Essay on Man:—

> "Learn of the little Nautilus to sail,
> Spread the thin oar and catch the driving gale"—

embody a wrong description of this very interesting survival. Pope believed, with many other people, that the little Nautilus comes to the surface keel downwards, and spreads some fleshy oval and ciliary expansions in the form of two sails and six little oars. But it does nothing of the kind. The two little oval expansions—the sails—are never raised at all, but always tightly clasp the shell. They form, in fact, part of the shell.

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The Standardization of Scientific Literature.

THE adoption of a uniform standard size for the pages of transactions and journals in which original papers are published possesses many advantages. In the first place it is a great convenience to be able to place the different series of bound volumes on shelves of the same size, and much space is thereby saved in libraries. The large amount of scientific literature published at the present time renders this aspect of the question of great importance. There are few libraries in which the difficulty of providing sufficient accommodation is not keenly felt. In the library of the Royal Society more space is badly needed, and unless every inch of room can be utilised the congestion will only be aggravated.

But there is a further advantage in uniformity. Those who devote particular attention to any special branch of study, say radiation, thermodynamics, or the phase-law, will collect reprints of different papers dealing with the particular subject in question, and the value of the collection will be greatly enhanced if these reprints can be bound together into one or more volumes, easy of access, instead of lying scattered about and frequently getting lost or mislaid.

In 1894 a Committee of the British Association was appointed to enquire into this subject. Their report was published in the *Report* of the Association for 1895. But such matters are apt to be overlooked unless attention is frequently directed to them, and there is imminent danger that a leading journal of mathematical proceedings in this country may adopt a retrograde policy, which will place it in a position of glorious isolation, and prevent it from being included either among the quarto or octavo volumes issued by the majority of British and foreign societies.

A collection of scientific literature, when arranged in order of sizes and pages, assumes roughly the form of a truncated pyramid, measuring, say, 4½ by 7 ins. at the top and 10 by 15 ins. at the base. But it will be found that nearly all the octavo journals in which original papers are published, at any rate, in mathematics, physics, or chemistry, approximate sufficiently nearly to the size of the Royal Society's *Proceedings* to allow of their being bound together without the binder's guillotine cutting away the letterpress. The same is also true of quarto journals, such as the *Philosophical Transactions*. By cutting away the margin most of these can even be included in the same volume with the slightly smaller *comptes rendus*.

Recognising this fact, the Committee found that while it would be a great convenience to have absolute uniformity in the sizes of the paper and letterpress, no inconvenience would arise from the retention of the existing sizes provided that (1) the paper was not *less* than a certain limiting size; (2) the printed matter did not occupy *more* than a certain size. The Committee, while, therefore, recommending the adoption of a *standard size* in the case of new journals, or changes of size, also laid down certain *limits of size*, which would obviate the inconvenience of changing the sizes of journals approaching sufficiently near to uniformity. In measuring the size of the *letterpress* the width must be taken from the stitching to the outside edge of the printed matter (thus including the margin between the letterpress, but excluding the outside margin), and the height from the top of the running headline to the foot of the letterpress, excluding the signature. The dimensions recommended were as follows:—

	Octavo.	Quarto.
Standard size of pages	14cm. × 22cm.	22cm. × 28·5cm.
Limiting size of pages *not less* than	14cm. × 21·5cm.	21·5cm × 28cm.
Standard size of letterpress	12cm. × 18cm.	18·5cm. × 21·5cm.
Limiting size of letterpress *not greater* than	12·5cm. × 18·5cm.	19cm. × 23cm.

The standard sizes are those of *demy* octavo and quarto respectively. In reality, *medium* is as common a size as demy, but as the pages are a little larger and the letterpress almost invariably falls well within the limiting size, no great advantage would arise from changing from medium to demy. Between the octavo and quarto volumes a gap exists. The *Atti* of the Lincei Academy of Rome is pretty well the only journal of importance which falls into this gap. It will be a great misfortune if the *Proceedings* of the London Mathematical Society are changed from their present convenient size, and not only transferred to the gap in question, but issued in a form which is not even uniform with the *Atti dei Lincei*.

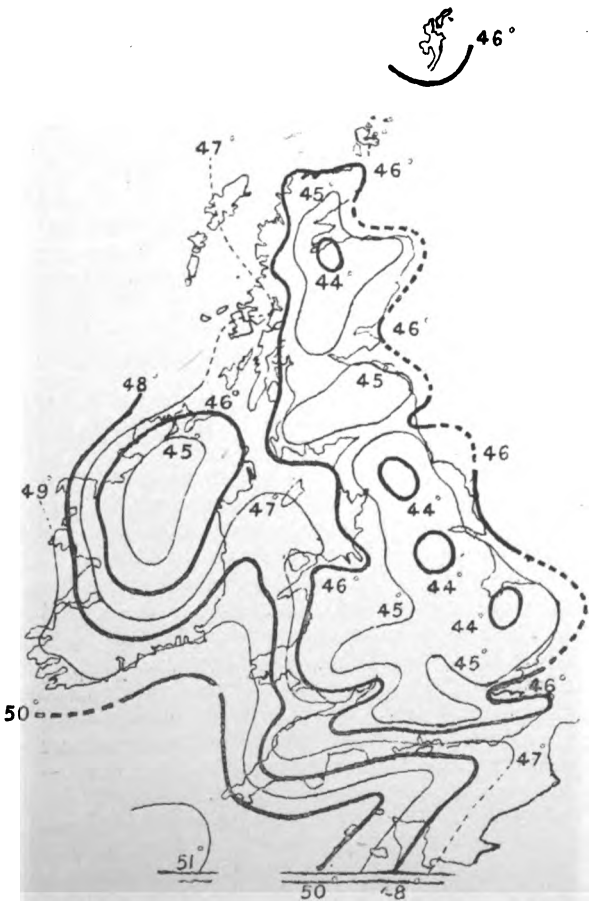
An Extraordinary Machine.

Rarotomato,
South Pacific Ocean.

Sir,—In this lonesome isle we seldom see the papers, as vessels only call here about once a year, so I am not very well up in the latest inventions. They tell me that a man in a neighbouring island has just imported a most marvellous machine, and though I myself do not believe for a moment all they say of it, yet you may be interested in hearing the account they give of it. The apparatus is said to consist mainly of two wheels connected together, one behind the other, by a framework. It is all built of metal. Now, they say that if a man sits on this frame he is able, somehow, to make the wheels go round, and, what is more, that he is thus enabled to travel at a great pace, much faster than he can run! Of course, there must be something wrong in this

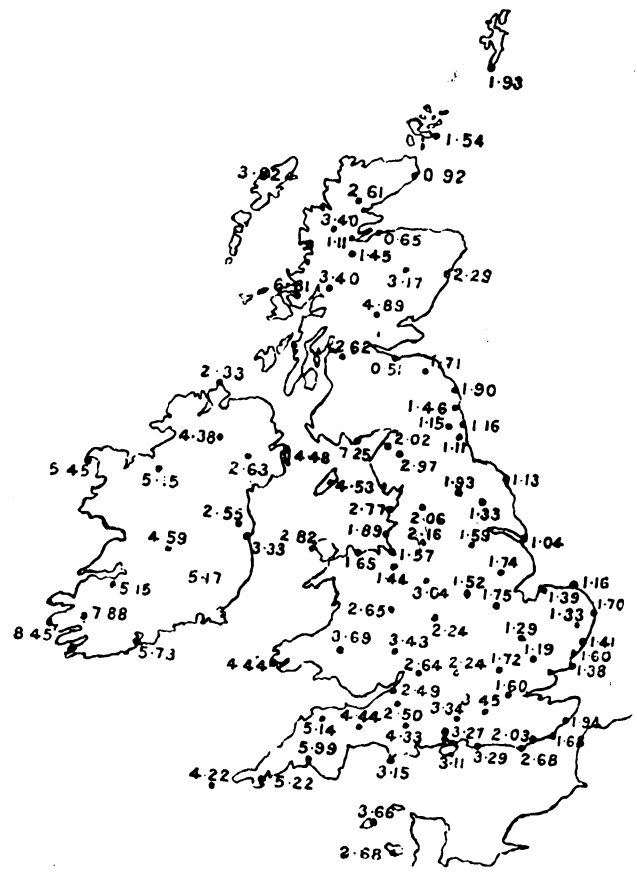
LAST YEAR'S WEATHER—NOVEMBER, 1902.

DISTRIBUTION OF MEAN TEMPERATURE.



The general distribution of temperature over our Islands was in fair agreement with the normal, but the actual values were above the average, the excess being slight in the south, but larger in the north, and especially in the north of Scotland, where it amounted in many places to more than 4°.

RAINFALL.



Rainfall was in excess of the average at most stations in Ireland and the south-west of England, but was deficient elsewhere; at many places in the northern parts of Great Britain the total amount was considerably less than half the normal, and at Leith it was less than one-fourth.

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description, for by applying his strength through a lot of complicated mechanism, in which there must be a considerable amount of friction, it would be manifestly impossible that he could get greater power out of the machine than he could get with his legs directly applied.

Besides this there is the weight of the heavy metal machine. No one could drag along a heavy weight and progress at a faster rate than without it.

Then, the arrangement of the wheels cannot be correctly described, for no man, except, perhaps, the most expert juggler or acrobat, could balance himself on two wheels only. My friend argues that a penny rolled along the floor will remain upright while rolling. True, but only while it *is* rolling at a good rate. Directly it stops it tumbles over. Besides, how could the man get on to the machine if it will only remain upright while moving rapidly along? No, I am afraid they are romancing, or else have got hold of quite a wrong notion of the whole thing. It may be that someone is trying to get up a syndicate to make some money. If so, he will not find *me* investing in it!

Yours faithfully,
R. KROOSEAU.

REVIEWS OF BOOKS.

Hertzian Wave Telegraphy. Dr. J. A. Fleming's invaluable Cantor Lectures on Hertzian Wave Telegraphy have been published in book form by the Society of Arts, before whose members they were delivered. At the time of their delivery the lectures packed the Society's theatre with scientific men, experts and engineers, and in their collected form they will find a purchaser in every intelligent student who desires to apprehend the actual and scientific basis on which existing systems of wireless telegraphy are founded, and to understand the extent and architecture of the superstructures which have been built on that foundation, as well as the possibilities of extension which the future offers. Starting from a consideration of the nature of the electric oscillations which are propelled outwards from the aerials used in practical wireless telegraphy, Dr. Fleming discusses in succession the theory of the Hertzian wave and the influence theory has had on the construction of the aerial antennæ, or the radiators of Marconi, Marconi-Braun, Seibt and Slaby Arco. Similarly, beginning with the theory of the discharging apparatus, which he compares to the force pump employed in forcing sound waves into the cistern of a fog siren, he examines the various forms of interrupters of the induction coil, the Wehnelt, the Mercury Turbine, the Caldwell, the Campbell Swinton; and the various forms of oscillation transformers. Thence he proceeds to the examination of receiving arrangements and receivers, still showing their correspondence with some primary type from which they differ among themselves only in different adaptation of the first principle; and thus he describes the "Kumascopes" or wave detectors of Branly, Marconi, Blondel, Popoff, Lodge-Muirhead, Castelli; and the magnetic detectors of Rutherford, Professor E. R. Wilson, J. A. Ewing, and Fessenden; as also the various types of De Forest, Slaby, and Braun. Lastly he summarises the syntonic receivers, the syntonic transmitters, the multiple receiving aerials, the Anders Bull selector system and the devices which are now being elaborated in order to reach the goal of Hertzian wave telegraphy, which is the ability to send waves in given directions and to exclude them from other directions. We have called the book, which is published at a shilling, invaluable; and so indeed it is. We may say of it besides that it is a marvel of compression and links together the various systems on a connected basis of scientific theory in a way compassed by no other existing treatise.

Index of the Technical Press (Association de la Presse Technique, Brussels), 4/- annually, issued monthly, is a most laudable attempt to give, in concise form, a list of articles in contemporary periodicals on all branches of science. The arrangement and classification of subjects is, at first sight, somewhat complicated and difficult to comprehend, but one soon gets into the way of it. It is on what is known as the decimal system of classification. "All branches of human knowledge" are placed under ten headings and numbered thus:—

0. General Works.
1. Philosophy.
2. Religion.
3. Sociology.
4. Philology.
5. Natural Science.
6. Useful Arts.
7. Fine Arts.
8. Literature.
9. History.

Each of these classes is again divided into ten. Thus to take No. 6, "Useful Arts," we have—

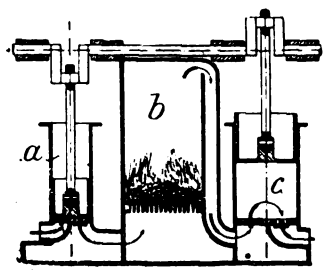
60. Useful Arts.
61. Medicine.
62. Engineering.
63. Agriculture.
64. Domestic Economy.
65. Communications and Commerce.
66. Chemical Technology.
67. Manufactures.
68. Mechanic Trades.
69. Building.

Each of these divisions is again divided into ten sub-divisions, and so on. Thus we find—

620. Engineering.
621. Mechanical Engineering.
621.1. Steam Engineering.
621.2. Water Engines.
621.3. Electrical Engineering.
621.4. Air and Gas Engines.

In this way, when we know the number of our subject it is not difficult to find. In the Index, the following information is given: Author, Title, Journal, &c. (abbreviations not clear until they become familiar), Date, Length of Article (this is given in number of pages of the same size as that of the Index, a rather roundabout method of computation), and the price at which the cutting can be obtained. The headings and directions are printed in French, English, and German.

Recent Patents.

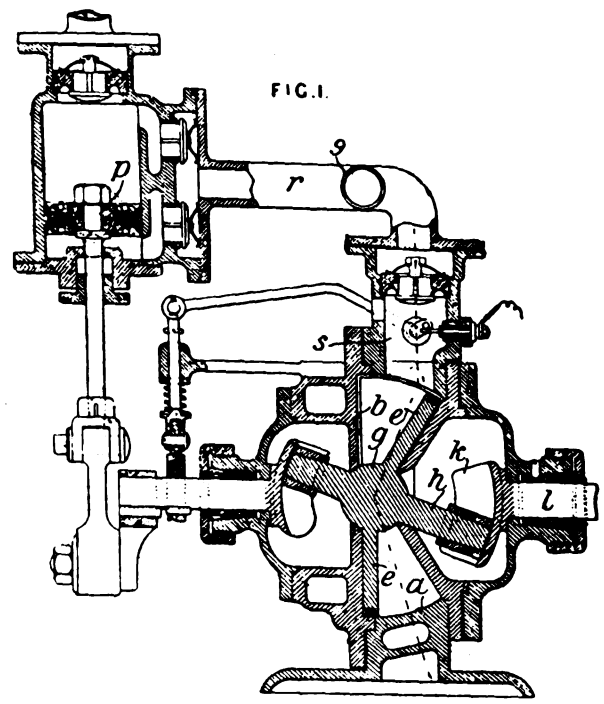


11,774. Furnace-gas engines. KLINGELHÖFFER, R., 8, Parcus strasse, Darmstadt, Germany. May 23.

Air is compressed by a pump *a* into a furnace *b*, where it supports combustion. The products thereof pass directly to a cylinder *c*, where they expand and work.

9,540. Rotary engines. CRINON, H. G., 20, Rue Joubert, Paris. April 24.

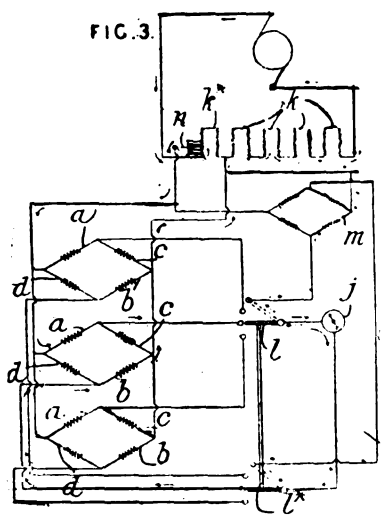
FIG.1.



Disc-engine type.—A rotary explosion engine has a spherical chamber *a* with a median partition *b*, and contains a conical piston disc *e*, which is slotted to engage with the partition. The piston disc works on a ball joint *g*, with projecting arms *h* which engage and drive cranks *k* on the shafts *l*. A pump *p* driven by the engine forces the explosive mixture through a pipe *r* into one of two similar explosion chambers *s* arranged on opposite sides of the partition and used for forward and reversed running, respectively. The reversing-cock 9 and the duplicate exhaust valves, not shown, are actuated by one hand-lever.

11,765. Thermometers. CRAWLEY, C. W. S., 44, Castletown Road, and TROTTER, A. P., 1, Campden Hill Square, both in Kensington, London. May 23.

FIG.3.



In an apparatus for measuring and indicating temperature at distance electrically, a Wheatstone bridge *a*, *b*, *c*, *d* is exposed to the temperature to be measured. The bridge has four coils of equal resistance at 0° C., but adjacent coils are composed of metals or alloys having different temperature coefficients, such as copper and german silver or iron and manganin. Two opposite junctions are connected to a battery or other source of electricity, and the other junctions are connected to a galvanometer *j* calibrated to read temperature. Three temperature-measuring bridges and a test-bridge *m* are shown adapted to be thrown into action singly by switches *l*, *l**. The current may be taken from an electric lighting circuit, the main current being passed through a bridge consisting of a number of section *k*, *k**. The Wheatstone bridges are connected to the ends of the sections *k**, a switch *n* being provided to adjust the current when the test-bridge *m* is in action. The sections *k* are made of german silver, and the section *k** and the galvanometer coil of copper or other materials arranged to give a constant current as their temperature varies.

11,982. Flying-machines. SEIBERL, J., Rolandsmühle, Bremen, Germany. May 26.

FIG.1.

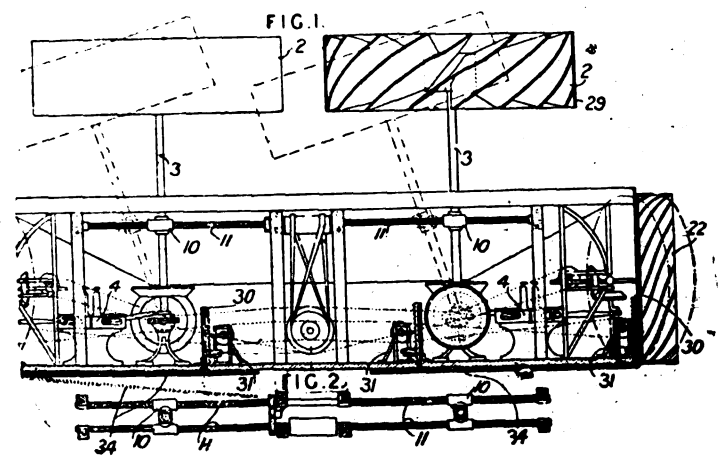


FIG.2.

The machine is lifted by two propellers 2 on shafts 3 with spherical ends engaging sockets fixed to the machine. The shafts are adjusted in inclination by screws 11 engaging nuts 10 on them. Horizontal propulsion is effected by propellers 22. Both sets of propellers are driven by benzene engines 4, and have cylindrical casings 29. Aëroplanes 34 beneath the machine are worked by the rack and pinion 30, 31.

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11,930. Gas and like engines. HÖFLINGER, E., Gleichenberg, Austria. May 26.

FIG. 1.

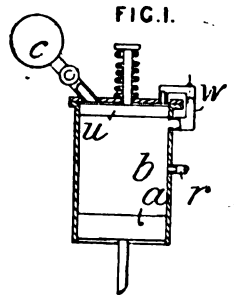
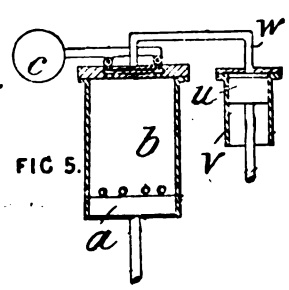


FIG 5.



The cylinder *b*, Fig. 1, contains a mechanically-actuated auxiliary piston *u* which assists in expelling the products of combustion through the port *r*, and towards the end of the motor piston's in-stroke forces a charge of compressed air from behind it through a pipe *w* into the space between the pistons where it is compressed till it becomes hot enough to vaporize the charge of fuel that is injected into it. This fuel may be ignited at constant pressure or constant volume, and may be injected through a nozzle situated in the mouth of the air pipe *w* and surrounded, if desired, by the exhaust pipe to heat it. Instead of employing the auxiliary piston, compressed air enters the cylinder from the reservoir *c*, and, after expelling the exhaust, air is drawn into a pump *v*, Fig. 5, and returned to the cylinder with the entering fuel. An upwardly-opening valve on the piston *u* equalizes pressure on both sides of it when that in the combustion chamber becomes abnormally high, and is raised by a projection on the piston *a* when they meet opposite the port *r*.

Prize Competition.

ONE of the principal objects of this journal being to encourage and foster the introduction and propagation of new ideas, the Proprietor offers a series of money prizes to those who, in his opinion, send in the best and most practical solutions to certain problems, which will be set each month.

The competitor gaining the greatest amount of marks each month will be awarded the monthly prize of ONE GUINEA. But in order to encourage clever inventors, and not merely reward those who may happen to hit upon a happy idea, a GRAND PRIZE OF **ONE HUNDRED POUNDS** will be awarded—after twelve problems have been sent—to that inventor who shall have gained the greatest aggregate of marks during that period, provided he shall have gained at least *30 per cent. of the full marks* in at least six of the competitions (whether he has gained a monthly prize or not).

RULES.

1. Designs to be sent in to the office before the end of the current month, accompanied by the coupon cut from this paper.
2. The solutions sent in must be concise, yet fully descriptive of the idea intended. To comply with this they must not exceed 300 words, and not more than two simple diagrams should accompany it.
3. Solutions will be published as considered desirable by the editor.
4. Competitors may obtain patent rights for their ideas, but they must run all risk of the publication in this paper interfering with the obtaining of such rights.
5. Competitors may send in their designs under a fancy name for publication, but their true names and addresses must be inserted on the coupon, which, in the event of their winning a prize, will be published. The same fancy name must be adhered to throughout in future.
6. The same person may send in two solutions so long as a separate coupon accompanies each. All marks so gained will count for the grand prize, but the monthly prize will only be awarded for the one best solution. If the two solutions appear to the judge to be but slight variations of the same invention, marks will be deducted from the second solution.
7. Novelty of design is not a *sina qua non* (since this would be extremely difficult to prove), but only the person sending a description with the coupon is entitled to reward.
8. It would add to the value if a statement be added to say if the design has been practically tried; but to corroborate this the inventor may be called upon to give a demonstration before receiving a prize.
9. In the event of an equality of marks or any other exceptional circumstances, the proprietor will decide on the fairest method of distributing the prize.
10. Non-compliance with the above rules may disqualify a competitor.

Owing to an error, the following solutions to No. 10 were not printed in the last issue:—

MEPHISTO No. 1 (**45**). Dust drawn by exhaust up pipe placed close behind each wheel, thereby "burdening the dust particles with the exhaust vapour."

MEPHISTO No. 2 (**38**). An exhaust fan causes current of air in funnel-shaped pipes attached to mudguard, opening near ground behind wheel. This sucks up dust raised into a chamber.

KASS No. 1 (**20**). A small roller covered with flannel placed close behind wheel, part of which is always in a water bath, kept supplied by reservoir. The dust adhering to wet surface is scraped of into a pan.

KAFFIR (**15**). Tank of water supplies spray directed behind wheel.

11.—Burglar Alarm.

CANTAB No. 1 (**70**). Two metal discs, separated by indiarubber ring, placed under carpet, and connected to electric bell.

CANTAB No. 2 (**23**). A number of flexible chains hung like curtain in front of windows and doors, so arranged that slight movement causes electrical contact to be made and bell rung.

MEPHISTO No. 1 (**30**). Rack and pawl concealed in window frame so that window cannot be opened, or opening increased, without disengaging pawl, which can only be done by electric switch at safe distance from window.

MEPHISTO No. 2 (**20**). Window fastenings, if undone between certain hours fixed by a clock, ring electric alarm. To circumvent window cutting, panes made double with partial vacuum between, with barometer-like tube of mercury to make electrical contact if glass broken.

BACILLIGRAPH. (**25**). Bolts to doors electrically connected. Fine wires across windows give alarm if pane cut out. "Receiver" either electric bell or Graphophone.

SECURE (**38**). In addition to giving alarm in the usual way by making contact when window or door is opened, the main wires are protected against cutting by smaller wires through which the current is perpetually flowing, the interruption of which releases an armature and rings bell.

A. C. T. (**28**). In a cavity in the door or wall a thin metal shutter is suspended so that any sudden variation in air pressure causes it to swing and complete electric circuit.

MOTOR (**25**). Projection on underside of window sash (or on door) presses down electric button in window frame. On window being opened electric contact is made.

K. O. H. (**50**). Two wires attached to hooks inside lower part of each window. Anyone attempting to enter would connect wires and turn on electric light. Arranged so that if wires cut, contact will also be made.

KASS No. 1 (**30**). Blind pulled down and cord attached to electric contact, so that bell is rung if blind is "bulged" from outside.

KASS No. 2 (**45**). An electric contact device to be fitted to door or window to ring bell, &c., when same opened, and put out of operation by small sliding bolt when not required.

R. FENTON No. 1 (**68**). Two pieces of metal ribbon, connected face to face at intervals with indiarubber pads, are connected with electric bell. Lengths of this are placed under carpets, &c., especially on stairs and passages. Anyone treading on them rings bell. Switched off in daytime. (*Now in actual use.*)

POLYPHEMUS (**40**). A string attached to door, window, &c., when pulled releases hook supporting a weight, which then rests on terminals of electric bell current.

R. FENTON No. 2 (**40**). Electric wires lead to each window and door, so fitted that contact is made directly they are opened beyond certain point. These are switched on at desired hour (by clock) and if any door or window is accidentally left open alarm will be given.

"CANTAB No. 1" has accordingly won the monthly prize and the sum of One Guinea has been sent to

R. G. C. GREGG,
Heather Lodge,
Burton Road,
Bournemouth.

Any competitors wishing for their original solutions to be returned to them are requested to send stamped and addressed envelope or cover.

PHOTOGRAPHIC COMPETITION.

As none of the specimens submitted in connection with the prize offered for photographs of clouds were considered by the judges to be of sufficient merit, or sufficiently typical of cloud formations, it has been decided that this competition be re-opened.

A prize of **FIVE GUINEAS** will therefore be given for the best series of

PHOTOGRAPHS OF CLOUDS,

typifying the various varieties—Cumulus, Cirrus, Nimbus, &c.

The photographs may be of any size, and need not necessarily be recently taken. Each photograph should clearly represent one type of cloud. They should be printed on any of the ordinary photographic papers, and will be considered as the copyright of this journal, and may be reproduced as found desirable. They should be sent in to this office not later than the end of March next.

COUPON.

To the Proprietor, ILLUSTRATED SCIENTIFIC NEWS.

I herewith forward specimen photographs for the competition of "Photographs of Clouds," according to the conditions published in your paper, and I agree to comply with those conditions.

Full Name .....

Address .....

.....

Fancy Name for publication .....

Date .....

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The Prizes of Science.

By T. E. JAMES.

FOR many years, in most countries where scientific studies have been systematically pursued, the award of gold, silver, or bronze medals in recognition of distinguished researches has received universal acceptance as an honourable and tangible expression of contemporary opinion regarding their character and worth. In addition to this mode, the practice is very generally observed of allocating gifts of money for work in identical fields of study, a course which it would be mere affectation to deny is substantially on all-fours with the medallic custom. It is one widely recognised as suitable for the purpose in view, moreover, involving no derogatory issue. Rash indeed the critic who would depreciate such rewards, seeing that they are annually accorded approval at the hands of world-known scientific academies and societies, and show every sign of a vigorous maintenance.

In Great Britain, as compared with other centres, the award of medals for past and present achievements in science finds fuller favour, it must be confessed, than that of money prizes. However that may be, the practical aspects of such monetary gifts undoubtedly appeal; and when they minister to the necessities of science, as we may safely believe they really do, their propriety can hardly be gainsaid. For example, Mme. Curie has on three separate occasions since 1897 received the Gegner prize of 3,800 francs from the Paris Academy of Sciences for her researches in radium—a foundation primarily intended to reward the prosecution of fruitful work. The question might, in fact, be asked in this connection whether it is not an open secret that many gold medal appropriations are themselves, with lapse of time, converted into current coin of the realm, and the proceeds used towards the purchase of requisite apparatus, or expensive books of reference bearing upon current researches. We need not quibble if the reply is in the affirmative.

Prize awards, in the categories under reference, are frequently announced for allotment two, three, or more years ahead, this, of course, depending upon the periods of time incidental to the terms of the various bequests or donations, whether, say annual, biennial, triennial, quadrennial, quinquennial, or even of longer interval, for there is at least one instance of a twenty-year period. The subjects with which they deal are essentially of the most composite nature; some relate to specially named investigations, ear-marked, as it were, for competition; others are given independently as the result of a selection of suitable recipients. The machinery of award that is involved thereby, demands, as may be readily imagined, anxious thought, and much disinterested labour on the part of many men of science of all nations, in order to secure catholicity of interpretation and of distribution. Hence it is satisfactory to gather that rarely indeed are decisions canvassed, or that the discordant note of dissatisfaction is heard.

A complete *résumé* of scientific prizes would manifestly be impossible in these pages, but some attempt may be made to furnish a conspectus of the pecuniary awards of the principal academies of those countries where the promotion of science is thus encouraged, and particularly in the natural and physical sciences.

The record of money prizes for Great Britain admits of brevity. Apart from the sums—and these are moderate—which frequently accompany the conferment of medals, forming the balances of funds with which the awards are associated, there are few gifts that may be strictly defined as prizes, except in the sphere of medical science, where they crop up in fair number. The stream of tendency as a matter of fact flows otherwise, chiefly in the direction of research fellowships, studentships, scholarships, or similar modes of endowment, by means of which the pursuit of various branches of science is encouraged, and research in its higher stages promoted. For instance, at Cambridge, there is the Balfour Studentship of £200 per annum for original research in biology, tenable for three years, and the Walker Studentship in pathology of the same value; while in London the Royal Society administers two Mackinnon research studentships, each of the annual value of £150, and tenable for two years. Others need not be specified to illustrate the point. Although no usage of the appellation is in force, a grantee under such foundations may be, perhaps, appropriately denominated a laureate of English science. The Actonian prize of one hundred guineas is in the possession of the Royal Institution, and is awarded every seventh year. In 1900 it was given to Sir William and Lady Huggins for the work, "An Atlas of Representative Stellar Spectra." The Gunning Victoria Jubilee prize is given triennially by the Royal Society of Edinburgh, and is open to men of science resident in or connected with Scotland.

In considering France we can only deal with one organisation, namely, the Paris Académie des Sciences. It is the trustee and administrator of an extensive series of enviable gifts embracing practically every department of scientific activity. At the end of the present month (which, by-the-way, marks the close of the 237th year of the Academy's existence), the annual public assembly is to be held at which the prize awards of medals and of money will be announced. The latter range in value from 200 francs (£8) to 100,000 francs (£4,000), and reach for the year 1903 an aggregate of 371,500 francs, equivalent to no less than £14,860—in itself striking testimony to the attitude and sustained liberality of Frenchmen where scientific objects are concerned. From the almost bewildering array of prizes set forth, a few may be picked out which possess features of special interest. The two highest are each of 100,000 francs, respectively the prix Pierre Guzman, and the prix Bréant. The Guzman memorial foundation is transferred absolutely to anyone who shall find a means of communicating with a planet other than Mars, but associated with this apparently impossible fulfilment is the provision that in default of interim allotment, the interest of the capital shall be given quinquennially for the most important advance in astronomy. Unless the unexpected occurs, the Academy will apportion the interest in 1905, and for the first time. The Bréant is framed on similar lines, but in this case the capital sum is to be awarded for the discovery of a radical cure for Asiatic cholera, or for the successful adoption of preventive measures, while the interest forms an annual prize in kindred research. May the prime amount undergo absorption! The Jean-Jacques Berger gift of 15,000 francs (£600) has civic significance, being awarded alternately by the five Academies of the French Institute for meritorious service relating to ameliorative conditions or measures affecting the people of Paris. If we take the year 1899—and the judges then included the names of Berthelot, Bertrand, Brouardel, and Marey—it is seen that the decision was taken to give this handsome prize to the Institut Pasteur, in recognition of its laudable efforts to secure diminution in diptheritic infection in the city. Next year the cycle of time brings this gift once more within the choice of the Academy of Sciences. Lower down in the scale of value we come across no fewer than seven prizes of 10,000 francs each (£400). Very interesting, too, is the series of Montyon prizes established in 1780 and onwards by the noted Baron Montyon (1723-1820). The Académie des Sciences,

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Académie Française, and Faculté de Medicine each dispose of large sums under the terms of his enlightened benefactions. Among the eight awards comprising the scheme are those of 2,500 francs for work in medicine and surgery; also 2,500 francs and 1,500 francs as recompense for the introduction of remedial measures intended to lessen the evils attending unhealthy trades and manufacturing concerns, familiarly known as the "unhealthy trades" prize. Incidentally, it may be mentioned that one gift in the Montyon group is set apart for the reward of acts of virtue amongst the poor, where the spirit of self-abnegation is manifest. It is administered by the Académie Française. The name of the great Laplace is commemorated by an annual prize founded by Mme. la Marquise de Laplace, consisting of his collected works awarded to a chosen scholar of the Ecole Polytechnique. The French Society also possesses two foundations due to the liberality of Englishmen. The annual prix Wilde of 4,000 francs (£160) arose out of a capital gift by Mr. Henry Wilde, F.R.S., of Alderley Edge, Cheshire, who was an early pioneer in electrical science. The interest constitutes a reward for original work in either astronomy, physics, chemistry, mineralogy, geology, or mechanics, irrespective of the nationality of the recipient. The Academy has the power to halve the sum and make two allocations if it thinks fit. The prix Hughes is of later institution, the outcome of the bequest, in 1900, of £4,000 by the late well-known electrician, and inventor of the microphone, Prof. D. E. Hughes, F.R.S. It is for original discovery in the physical sciences. The first adjudication of this English prize in the sum of 2,500 francs will be announced at the meeting referred to above; afterwards it takes rank as an annual allotment. Prof. Hughes bequeathed like amounts to our own Royal Society and Institution of Electrical Engineers. The former devoted their legacy to instituting a gold medal coupled with a small money gift, and within the last few days the Hughes medal has been presented to the veteran Prof. Wilhelm Hittorf, of Munster. It is a sign of the times that neither in France nor in England is any restriction of sex or nationality allowed to weigh in the selection of recipients. Before terminating this section it may be mentioned that so far as the foregoing series is concerned the names of men of science who are English appear at intervals, but few and far between, hence it is desirable to chronicle one or two instances of such sporadic awards. The most notable was undoubtedly the gift of 50,000 francs (£2,000) in 1895 to Lord Rayleigh and Prof. Ramsay for their memoir on "Argon," forming the prix Leconte. Again, in 1897, Dr. A. D. Waller, F.R.S., received the "Parkin" prize of 3,400 francs for a paper presented in the division of medicine and surgery.

Passing now to Belgium, the Académie Royale de Belgique, in the Classe des Sciences, offers a considerable number of competitive prizes for set subjects in natural science, as well as in mathematics and physics; and in addition, "Prix Perpétuels." The former amount, for the current year, to the substantial sum of 7,800 francs (£315), awarded on the recommendation of recognised referees, while the latter total a figure of 10,000 francs (£400), four of them being apportioned independently of the nationality of the competitors. Certain of the prizes are of quite recent institution, so that the still living donors, as in corresponding cases elsewhere, enjoy the satisfaction of periodically witnessing the channel of distribution through the decisions of the judges. Others, like the biennial Théophile Gluge prize in physiology of 1,000 francs, established by M. Jaffé and Mme. Anna Gluge, gratify the wish of the relatives of a deceased savant to perpetuate his memory and life-work in his own province of research.

Italian Societies make up in richness of gifts what they lack in number, and Turin is especially to the fore. The Bressa quadrennial prize ofthe Royal Academy of Science, Turin, is of 9,600 lire (about £400), and comes up for award in 1904. It is intended to recompense the most notable scientific work achieved in the period, and is founded on a wide basis. The Vallauri Prize of the same Academy is of 30,000 lire (£1,200), for a grand work in the physical sciences, and is allotted irrespective of nationality. The Gautieri Prize in philosophy is of the value of 2,500 lire. And finally, we must not omit the Riberi five-yearly gift of 20,000 lire (£800), for original work in anatomy, physiology, and other domains. The tenth distribution was made in 1901. The Bufalini Prize, at the disposal of the University of Florence, is worth £240, and next year will see its allocation, that date coinciding with the condition of a twenty-year distribution. The subject refers to the experimental value of scientific enquiry as opposed to the speculative. The original intention of this prize seems to have become outgrown and obsolete in useful purport with the strides of time, since experimental research is now but the diligent handmaid of speculation. The R. Accademia dei Lincei, Rome, awards King Humbert's prize of 10,000 lire, and other gifts.

Hungary, too, is within the circle of prize givers. The Academy of Sciences, Budapest, offers a quinquennial open gift called the "Bolyai," to commemorate the 100th anniversary of the birth of John Bolyai, the celebrated Hungarian geometrician, born in 1802. It is to be awarded for the first time in 1905 for the best work in mathematics that has appeared in the defined interval, and will consist of a medal, together with a sum of 10,000 krone. In this instance the course has been followed of establishing an adjudication Committee, whose members include not only Hungarians but two foreigners, and this body will meet in Budapest to discuss the claims and draw up conclusions for presentation to the Academy. The two strangers taking part in the deliberations will each receive an honorarium of 500 krone, while a "reporter" will be granted 300 krone. The mode of procedure thus adopted is clearly indicative of a desire to maintain the principle of the international fraternity of science.

Russia has no long catalogue of prizes, and in her case there is some difficulty in tracing them, owing to the circumstance that the usual announcements are made in the Russian language. In character they are very generally in line with those of other countries, the medallic and monetary custom being both observed. The Académie Impériale des Sciences, St. Petersburg, allots seven or more money gifts for papers in ethnology, zoology, and other subjects, but the particulars respecting them are somewhat scanty. They vary in amount from 500 roubles to 1,000 roubles. In 1902 four "Ouvarof" prizes were allotted, one being of 1,000 roubles and three of 500 roubles. A "Count Tolstoi" gold medal foundation in the possession of the Academy has no connection, it may be observed, with the eminent Russian novelist who bears the same title.

In the case of Sweden, all other gifts are thrown into the shade by the remarkable Nobel prize scheme, which came into effect a couple of years or so ago, and which provides for the annual distribution, in five equal parts, of £40,000. It is administered by the Swedish Academy under the bequests of Alfred Bernhard Nobel. Since the story of the foundation is recent enough to be within easy recollection, we need not recapitulate its terms, but it may be stated that there has been at least one English recipient of the sum of £8000, namely, Major Ross, F.R.S., on account of his researches in malaria. There can be little doubt that had these prizes originated earlier, an allotment by the Academy would have reached this country for the discoverers of "Argon."

Germany assigns many valuable prizes, and the practice of offering monetary rewards for the encouragement of investigations in subjects considered worthy of study is by no means uncommon. The system of theses is also much in vogue, while borderland or abstract researches are energetically promoted. The Berlin Academy awards several prizes. The "Steiner," of 6,000 marks, is for work in geometry; the "Leibnitz" of 5,000 marks; and gifts of 2,000 marks and 1,800 marks are given for philosophical studies. In 1900, the University of Göttingen allotted the Volbrecht prize of 12,000 marks (£600) for scientific research, to the late Dr. Carl Gegenbaur, then professor of anatomy in Heidelberg University. The Scientific Society of Dantzig gave a prize of 1,000 marks to celebrate the prestige of its 150th anniversary, a memoir on the geology of North Germany forming the selected subject. The K. Gesellschaft der Wissenschaften, Göttingen, is also most liberal, as anyone may see who consults its "Nachrichten." And the catalogue is capable of further extension.

The Madrid Royal Academy of Sciences awards medals, and a limited number of prizes in competition. In 1906 the Barcelona prize of 20,000 pesetas for the best original work on Spanish archæology is to be allotted. It arises out of a legacy bequeathed to that city.

The munificence of Americans in connection with the endowment of science in its various paths and bye-ways is too well known to need comment. The Smithsonian Institute is trustee for the rich Hodgkins Fund, established for investigations of the properties of atmospheric air. In 1896 the memoir by Lord Rayleigh and Professor Ramsay detailing the methods which led to the discovery of "Argon" was submitted in competition to the Hodgkins Fund Committee, and the authors were awarded the principal prize of 10,000 dollars (£2,000). The Carnegie Institution of Washington, lately founded, arises out of the gift of £2,000,000 for the encouragement of investigation, research, and discovery. It is not likely, however, that large money gifts in the nature of "prizes" will form part of the policy of administration of this splendid trust.

The need has long been felt for a compilation furnishing the conditions of award of such gifts as are here summarised. Possibly the "Handbook" upon which Mr. Cyrus Adler is engaged, under the auspices of the Carnegie Institute, may supply this want in convenient form.

Simple Illustrations of Refraction and Production of Foci.

WHEN descending the Rhine in a steamer this summer I noticed an interesting illustration of the law of refraction of light. In one place the current was confined within parallel weirs, behind which the water was at rest. The waves produced by the wash of the steamer overflowed these weirs and caused a second series of waves to strike off in the still water in a different direction to the incident waves, consequent on the wave-velocity being different in the still and running waters. When the steamer rounded a sharp corner, the curved waves were seen to converge to a focus at which a violent disturbance was produced. These effects lead me to suggest that it might be possible to illustrate the phenomena of refraction and the production of images according to the undulatory theory by means of ripples produced in a shallow tank suitable for class-room demonstrations. In this case the refracting media will be represented by shallower or deeper regions, which can be easily cut out of wooden boards fixed to the bottom of the tank.

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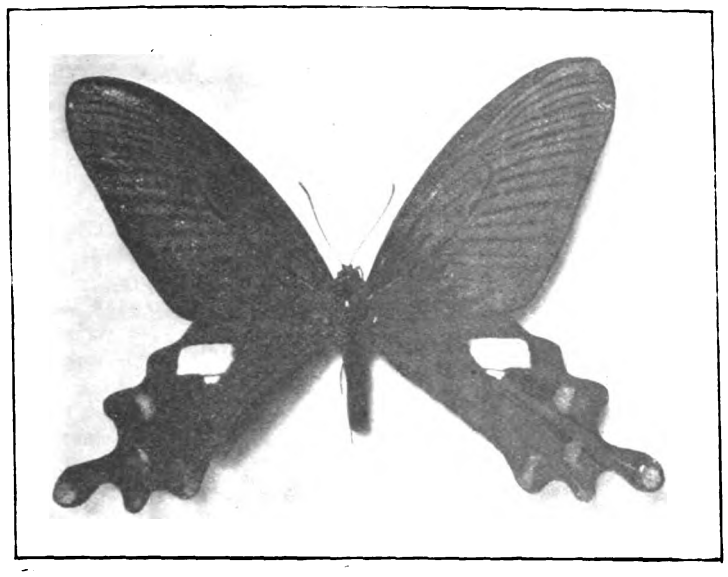
Butterfly Tails.

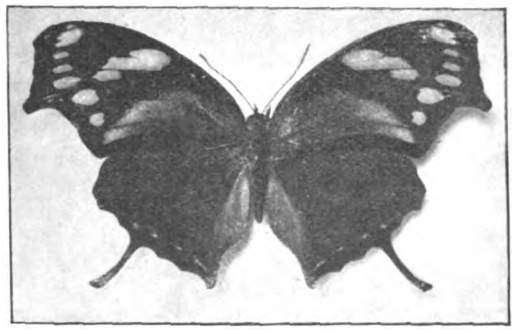
By PERCY COLLINS.

"SWALLOW-TAILS" is the pretty name bestowed by popular fancy on the immense group of butterflies included in the scientific genus *Papilio*. Certainly the quaint wing appendages, seen in so many



Papilio philoxenus from Assam.

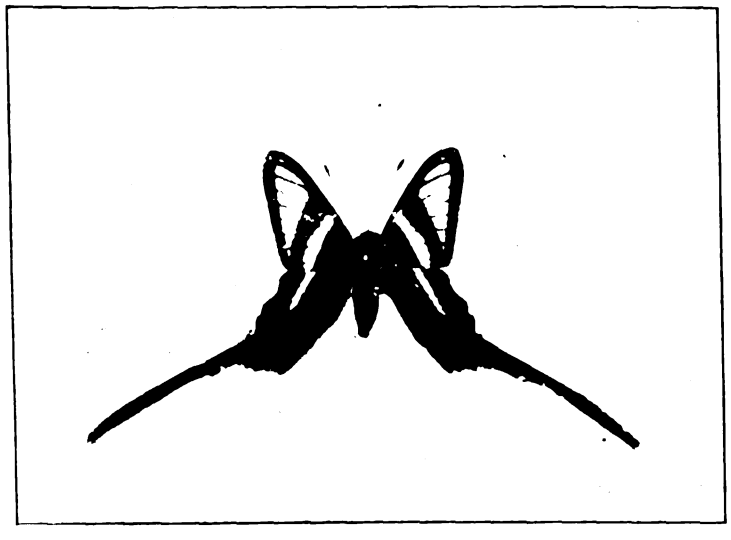
species, bear no small resemblance to the long outer feathers in a swallow's tail, and from this, doubtless, the name took its origin. "Swallow-tail" butterflies are found in all the warm regions of the globe; and although many of the species have rounded wings, con-



Protogonius from Bogota.

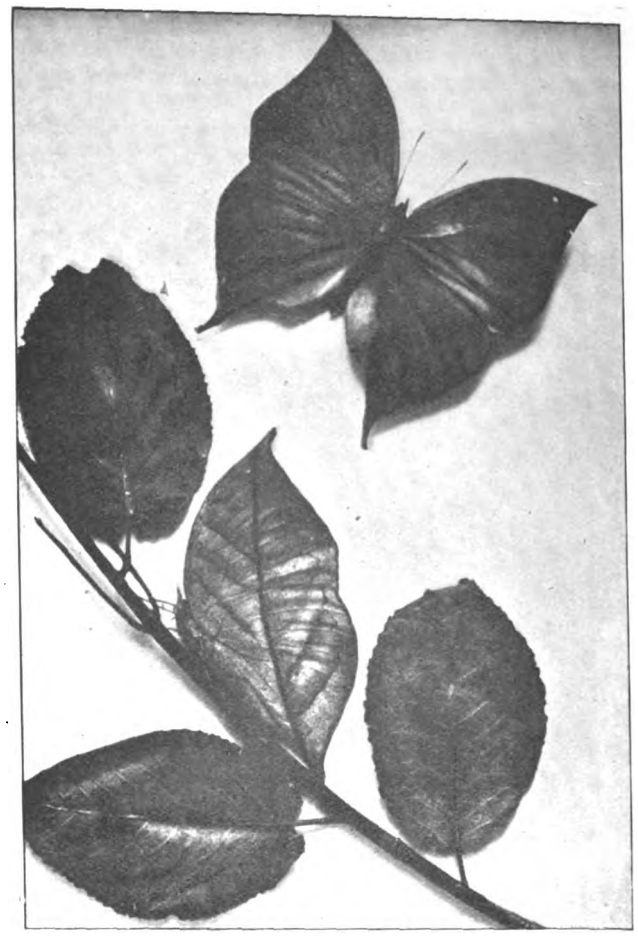
forming to the more simple butterfly type, the "tailed" kinds are sufficiently numerous in every country to give a marked character to the group.

The "tails" vary greatly both in shape and in length. Perhaps



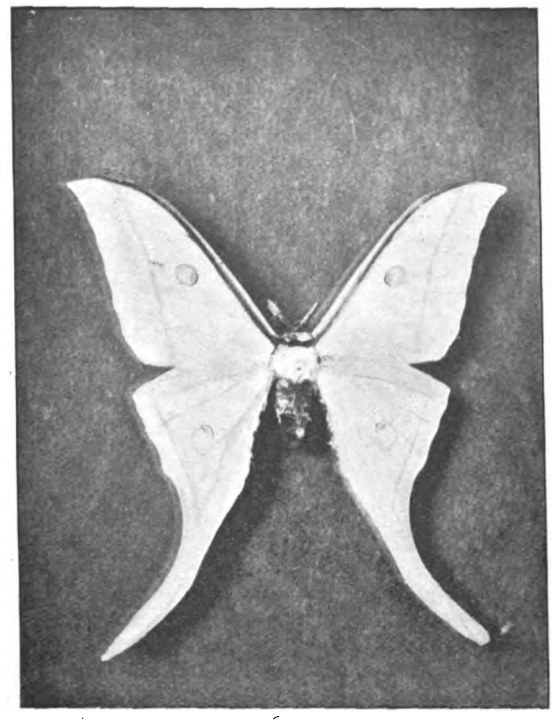
Leptocircus curius from Assam.

those of the South American species allied to *Papilio autosilaus* and to our own scarce "swallow-tail" approximate most nearly to the bird prototype. In the tropics of the Eastern Hemisphere, the characteristic "tail" may be described as paddle shaped, as in *Papilio philoxenus* or *P. rhodifer*. Between these two extremes, *Papilio* wing "tails" assume an infinite variety of form, sometimes beautiful, sometimes strange and almost grotesque. But Papilios are by no means the only butterflies possessed of these curious appendages. Indeed, they occur in certain groups of several of the large butterfly families. In most cases, the causes which have led to the development of these "tails," as well as the objects served by their existence, are exceedingly obscure, though observation of the insects' habits has in some cases thrown light upon the matter. The "tails" of certain Nympha-



The Kallima Butterfly, from India.

line butterflies that gain protection from the assaults of insectivorous creatures by their resemblance, when at rest, to leaves, simulate stalks, thus enhancing the deceptive likeness. Such "tails" are possessed by the well-known Kallima butterfly, from India, which is one of the most striking leaf mimics known. When the Kallima's wings are closed, the "tails" are, of course, brought together, and touch lightly



Actias Selene.—A "Silk Moth," from India.

the twig or stem upon which the insect has settled, thus becoming the stalk of the apparent leaf. A glance at the accompanying photograph will make this clear to the reader.

Doubtless this explanation would apply to quite a large number of butterflies in both hemispheres which, when at rest, bear a greater or less resemblance to leaves. *Protogonius*, for instance, from Bogota, is tinted in exact imitation of a leaf on the underside. And the long,

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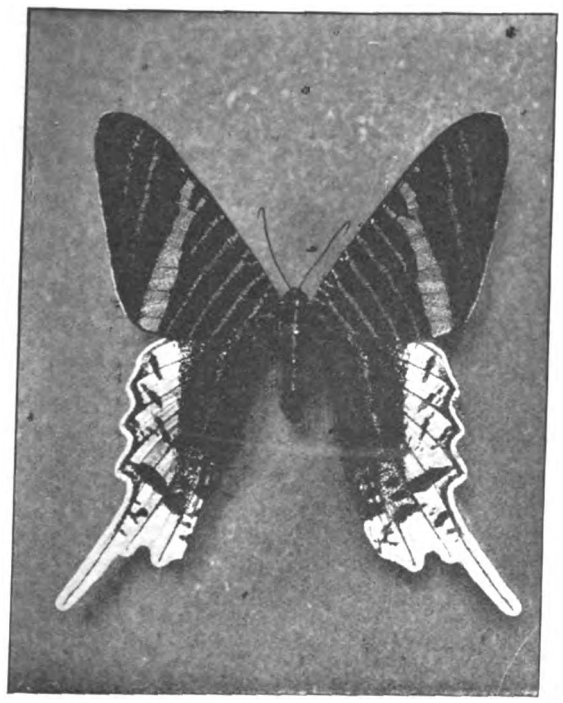
narrow "tails" of the hind wings must materially assist this resemblance when the butterfly is at rest with folded wings.

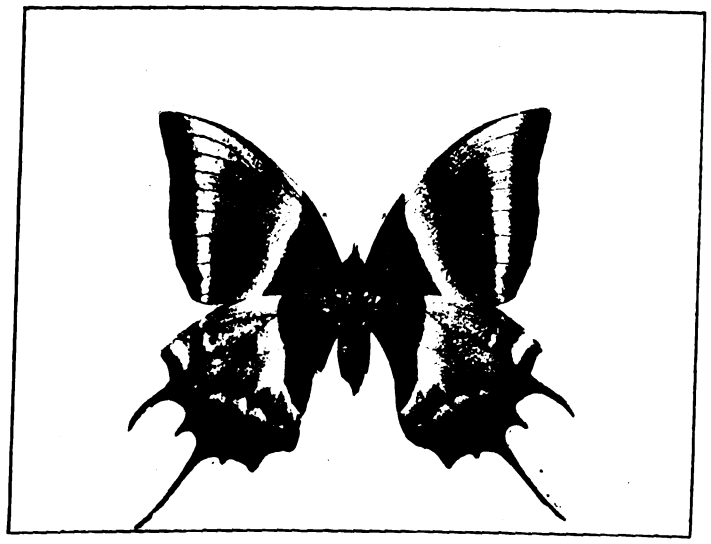
Perhaps the strangest of all "tailed" butterflies are the members of the eastern genus *Leptocircus*. These insects are quite small, none of the species measuring more than 1½ inches in wing expanse. So quaint is their appearance that one finds it difficult to credit that they are butterflies at all. They look like some nondescript creatures from another planet. Collectors say that the species of *Leptocircus* hover over water in company with Dragon-flies, to which insects they bear some resemblance when on the wing. It may be, therefore, that the



Urania Leilus, from Brazil.

quaint form of these butterflies might be in measure explained as aiding some mimetic likeness. Facts are wanting, however, to establish such a theory.

Many "tailed" butterflies look like veritable "freaks of nature." Take, for instance, the curious insect known as *Teinopalpus imperialis*, from Assam. Save for its almost unique green colouring, the male is not particularly striking, having only one "tail" to each hind wing as is the case with so many of its allies. But the female insect has no less than five "tails"—two long and three short—to each hind wing.



Teinopalpus Imperialis, from Assam.

"Tails" are by no means confined to butterflies—many species of moths possessing these curious appendages. The beautiful *Urania* moths, portions of whose wings are so often mounted as microscopical objects, are all "tailed." Certain genera of the large silk-weaving moths are also conspicuous in this respect, and in some instances the "tails" are so long as to seem absolutely cumbersome.

In conclusion, it may be suggested that just as conspicuous eye-spot markings upon the wings of moths and butterflies are thought to benefit the possessors by "drawing off" the attacks of birds, so wing "tails" might be thought to serve a like purpose. Injury to the wings of insects is not likely to prove fatal. And if a pursuing bird pierced with its beak an eyespot, or tore off one of the "tails," the butterfly might still hope to escape with its life. Moreover, after a number of futile attacks, all aimed at the wings, it is conceivable that the bird might be led to abandon the chase in disgust.

The Stone System of Wireless Telegraphy.

Selective Signalling.

CHIEF of the difficulties of wireless telegraphy stations is that of avoiding the reception of messages and signals not sent to them, or desired by them.

Mr. Stone's system aims to do away with this difficulty. His work deals nearly altogether with selective signalling. Broadly, he makes use of a sending apparatus that emits simple hurricane waves of a fixed and determined period, not a number of waves of different periods all jostling one another, as other systems do. Similarly he has a receiving apparatus which responds to waves of one period only. Other waves do not disturb it.

Mr. Stone makes use of the properties of resonant circuits. A single circuit with a capacity and an inductance included in it has a definite period of electrical vibration—just as a tuning fork, or a suspension bridge has a definite period of vibration. If electro-motive forces of different periods, including one where natural period is the same as the natural period of the circuit, be impressed on our circuit, then the current due to the electro-motive force of the same period as itself will be exaggerated, while the current due to the electro-motive forces of the others will be to a large extent suppressed. (Similarly a pendulum can be given a bigger swing by timing the impulses which one's finger gives to it; but if these impulses are badly timed, the effect is lost.) But now let us suppose our original circuit to be placed in inductive relation with a second circuit. In this case the natural periods of both circuits will be modified by the forces impressed on them. But supposing L′ and L″ to be their respective self inductions and M their mutual induction, then this modification will be unimportant provided that $L' \times L''$ is very great compared with M^2. So by filtering an electric vibration of mixed periods through a number of such circuits—circuits having the same period and placed in inductive relation—we can get rid of the mixed impulses effect, and finally arrive at a vibration of a single period. That is to say, we can arrive at a simple harmonic wave.

So far we have considered the natural vibrations of the system. But if an electro-motive force of a period different from the system's natural period be impressed on it, the system must execute "forced" electrical vibrations of a period equal to that of the impressed electro-motive force. The mechanical analogy is exact and evident. If a simple harmonic electro-motive force be impressed on a system the result will be a simple harmonic current of the same period.

This is the principle of Stone's transmission device.

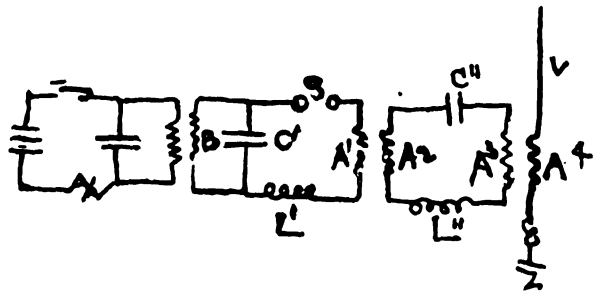


Fig. 1.

An induction coil has a secondary B, and a spark gap S. On a discharge taking place across the spark gap, an oscillating discharge from the condenser passes through the circuit S A′ L′ C′, this circuit being so timed that it responds to the period desired. In inductive relation to it is a second circuit $A^2\,C''\,A^3\,L''$, timed to the same period, and in turn placed in inductive relation with the vertical wire V through the coils $A^3\,A^4$. (The coils A^1, A^2, A^3, and A^4 consist of a few turns of wire wound on a wooden frame. The inductances L′ L″ are placed in the circuit to guarantee the condition that $L' \times L''$ is greater than M^2.) Any number of intermediate circuits similar to $A^2\,L''\,A^3\,C''$ might be used to filter the waves still further, but in practice it is not necessary to multiply them. The use of this apparatus gives the following result: We have impressed in a continuous vertical conductor simple harmonic waves of a definite and determined period. We can alter this period as we wish by changing the value of the inductance and capacity.

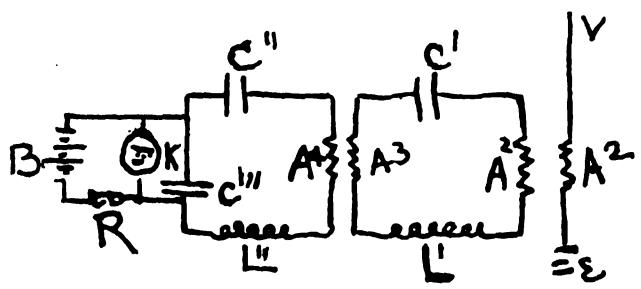


Fig. 2

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Now for the receiver. If we have a recurrent circuit such as we have been considering; and we place it in inductive relation with a circuit on which is impressed an alternating electro-motive force, then as the period of this outside electro-motive force approaches the natural period of the circuit, the current in the circuit increases rapidly. It reaches a well-defined maximum when the two periods are equal. If the impressed wave is not simply harmonic but has mixed with it a number of waves of higher periods, then the maximum is not so sharply defined and some of the more rapid waves will appear in the resonant circuit. Even simple waves would cause the circuit to execute forced vibrations. But to prevent this happening we may employ the same means as at the transmitting end. That is to say we may place a second circuit which has the same period as the first circuit in inductive relation with it; and now we shall have a combination which will not respond to the mixed waves, but within narrow limits will respond to waves of one period and one period only—that is to say, to the simple harmonic wave that is being sent out to it from the transmitting aerial.

This is the plan Mr. Stone has. In figure (2), V is the vertical wire containing the coil, A^1 in inductive relation with the coil A^2 of the resonant circuit A^2 C′ L′ A^3. This circuit is in its turn in inductive relation with the circuit of equal period A^4 C″ C‴ L″ by means of the coils A^3 and A^4. Across the condenser C‴ in the latter circuit is the coherer. The coherer, or kumascope, K, is a small tripod made of three steel needles attached at their upper ends and resting on a plate of aluminium. Great sensitiveness was not sought for; in fact, rather the reverse. The vertical wire for sending out signals is continuous. Vertical wires with spark gaps cannot send out simple harmonic waves of one selected period, while the Stone system can.

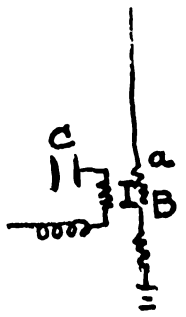

Fig. 2.

The potential difference usually obtained at the spark gap at B is obtained by changing the rates of transformation at I. By these means Mr. Stone has found an apparatus to do two things—(1) to send out simple harmonic waves for a definite period; (2) to receive them in an apparatus that does not respond to other electrical disturbances.

The system is in actual operation between Cambridge and Lynn, in Massachusetts.—E. S. G.

Magnetic Waters of Indiana.

CHEMISTS are always inclined to show scepticism when they hear of waters that communicate magnetic properties to steel objects plunged into them, and strenuously combat any such idea.

The *Genie Civil*, which comments on this fact, quotes an article from the *Engineering News* about magnetic waters, which tends to prove that the scepticism of the chemists is hardly justified. Actually, according to the Leighton hydrographer at Chicago, there are in the State of Indiana three springs which magnetise needles, blades of knives, &c. The first is at Cartersburg Springs, the second proceeds from a bored well at Lebanon, the third from a bored well at Fort Wayne. These waters contain a large proportion of carbonic acid, which escapes on exposure to the air. As the gas escapes a heavy precipitate of oxide of magnetic iron is formed, and when all the gas has disappeared no magnetic property any longer is manifested. It is probable that the iron in solution corresponds to a carbonate.

Experiments were made at Cartersburg Springs. Knives, needles, tried during the journey and on arrival near the spring, do not show any trace of magnetism. After five minutes' immersion, a knife blade supports the needles end to end. The needles plunged into the water for two minutes remained attached to one another by their ends, in spite of the wind. The knife blade retained its magnetic properties about three hours.

It appears incontestably that these waters produce magnetism of steel, and become distinctly the needle of the compass.

The water of Lebanon proceeds from a well belonging to the Big Four Railway Company. It was noticed that its water was corrosive, and rapidly wore out boilers. An examination of the water by Mr. Hurtz, chemist to the Company, did not show the presence of any substance capable of producing those corrosions, and proved the magnetic properties of the water. They tried allowing it to remain for some time in a reservoir before using it, and since then there has been no fear of corrosion. At present the precipitation of the oxide of iron is obtained by means of an injection of steam.

It appears that the waters by Fort Wayne possess magnetic properties still more developed than those of the above-mentioned springs.

Astronomical Notes for December.

THE SUN.

ON the 1st day of the month the Sun rises at 7 h. 44 m. a.m., and sets at 3 h. 54 m. p.m. On the 15th he will rise at 8 h. 0 m. a.m., and set at 3 h. 49 m. p.m. On the former date the length of the day will be 8 hours 10 minutes, by the latter it will have shortened to 7 hours 49 minutes. The equation of time will be negligible on the 26th. Daybreak occurs on the 1st at 5 h. 41 m. a.m., and twilight ceases at 5 h. 57 m. p.m. The Sun's apparent declination at noon on this date will be 21° 40′ 18″ S., with an hourly variation of 24″.27, his right ascension on the same day being 16 h. 25 m. 28 s., the hourly variation amounting to 10.77 secs.

On the 23rd the Sun is said to enter the *sign* Capricornus, and Winter begins at 0 h. 20 m. a.m.

THE MOON.

The Moon will be full on the 4th, at 6 h. 13 m. p.m., and reach her last quarter on the 11th, at 10 h. 53 m. a.m. She will be new on the 18th, at 9 h. 26 m. p.m., her first quarter being attained by the 27th, at 2 h. 23 m. a.m. Our satellite will be in perigee on the 7th, and in apogee on the 23rd.

When full the Moon will rise at 4 h. 18 m. p.m., and at last quarter at 0 h. 23 m. a.m., whilst at first quarter she will set at 1 h. 3 m. a.m.

Occultations will occur on the following dates:—(1) On the 5th, when 130 Tauri (magnitude 5.5) will be occulted, but only the *reappearance* at 5 h. 17 m. p.m., at 294° from the true north point, will be visible at Greenwich. (2) On the 7th, λ Geminorum (mag. 3.6) will disappear at 5 h. 40 m. a.m., and reappear just one hour and one minute later, the points of ingress and egress being at 109° and 274° from the T.N.P. respectively. (3) On the 11th, d Leonis (mag. 5.0) will be occulted at 1 h. 14 m. a.m., at 168° from the T.N.P., and reappear 32 minutes subsequently at 230° from the point mentioned. (4) On the 31st, 75 Tauri (mag. 5.3) will be obscured at 8 h. 24 m. p.m., at 133° from the T.N.P., and will emerge at 9 h. 7 m. p.m., at 204° from the same point.

The Moon will be in *conjunction* with Venus on the 14th, Mercury on the 20th, Mars and Saturn on 22nd, and Jupiter on the 25th.

THE PLANETS.

Mercury will be an "evening star" during this month, but is best placed for observation at the end of the month, when he will set about one hour and a half later than the Sun. His R.A. and S.D. on the 27th, will be 19 h. 41 m. 24 s. and 23° 15′ 17″ respectively. His apparent disc will on this date be 6″.0

Venus is still a "morning star," rising at the middle of the month at about 4 o'clock. Her S.D. on the 17th will be 11° 52′ 41″, and R.A. 14 h. 28 m. 36 s. On the 3rd, when she rises at 3 h. 19 m. a.m., this planet will be in close proximity to α Virginis (Spica). Mars, though technically continuing an "evening star" insofar that he sets *after* the Sun, is just as uninteresting an object as last month, setting, in the middle of the month, at 7 o'clock.

Jupiter, in *quadrature* on the 8th, is fast losing the pre-eminence he has so long enjoyed as the brightest object of our evening skies. On the 7th, he *souths* at 6 h. 4 m. p.m., with S.D. 7° 13′ 29″, and R.A. 23 h. 5 m. 42 s. His disc will by that time have dwindled in apparent diameter to 37″.6.

Saturn continues an "evening star," but as he sets as early as 7 h. 16 m. p.m. on the 17th, this planet will have to be looked for as soon after sunset as possible. His R.A. on the date named will be 20 h. 36 m. 15s., and his S.D. 19° 20′ 2″.

Uranus comes into *conjunction* with the Sun on the 18th, and, for our present purpose, is virtually invisible throughout the month.

Neptune is now most favourably placed for observation, as he comes into *opposition* with the Sun on the 27th. On the 2nd he rises at 5 h. 31 m. p.m. with R.A. 6 h. 22 m. 36 s., and N.D. 22° 15′ 39″. At the time of opposition he will be situated almost exactly between μ and ν Geminorum.

The *minor planet* Vesta is still very satisfactorily situated for the observer, rising on the 10th at 3 h. 28 m. p.m., with R.A. 3 h. 55 m. 22 s., and N.D. 13° 19′ 9″. On the 5th she will be found midway between γ and λ Tauri, and at no great distance from Aldebaran, or the well-known group of the Pleiades.

THE CONSTELLATIONS.

Did we watch the heavens at midnight, there is no better season than the "witching hour" of a December night to observe the beauty of that brilliant constellation Orion, which, at the time named, decks the meridian with its resplendent host. But as it is customary for our observing hour to be arranged for about 10 p.m., we shall find this constellation still rather low to the south-eastward, whilst the meridian line will be occupied, as we look southward, by Perseus, Aries, Cetus, and part of Taurus, with the Pleiades making their usual test for a good sight; that is, to be able to see more than seven stars with the unaided eye. Further towards the east, Auriga, with chief star *Capella*, Gemini, with *Castor and Pollox* (the "Twins"), and Canis Minor, with *Procyon*, make a goodly show, whilst Canis Major, with *Sirius*, is just appearing above the south-eastern horizon.

Turning to the north we observe Ursa Minor in an upright posture, while just to the east of him, the Great Bear reclines near the horizon, and further on in the same direction, the "Sickle of Leo" is just coming into view.

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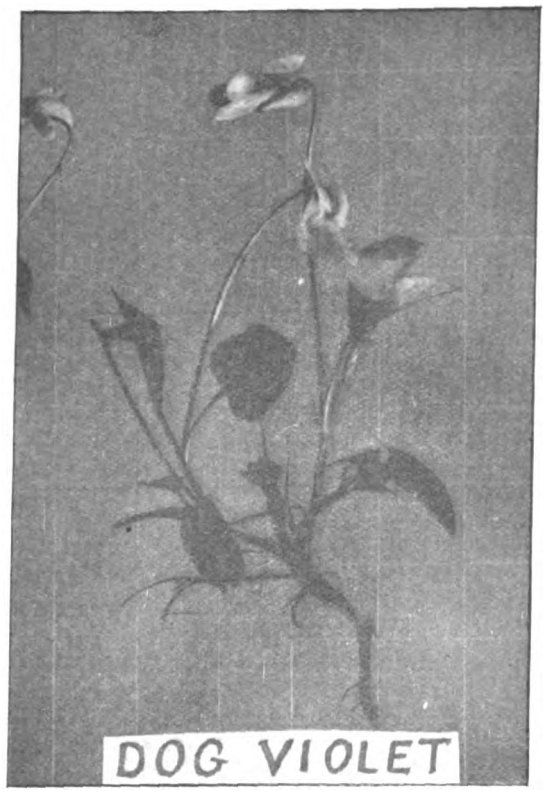
The Natural History of British Wild Plants.

By J. C. SHENSTONE, F.L.S.

IV.

WE have now progressed far enough to have observed that the endless variation in the forms of plants is due to a tendency to become more highly organised, and thus to become adapted to the varying conditions under which plants must live.

No two plants from a number of seeds, produced by the same plant, would be found to be exactly alike. Nor would any one of them



exactly resemble its parents, yet they would more closely resemble their parents and one another than plants produced from other seeds. This tendency to variation is much stronger in some genera than in others, and those genera in which the tendency is strongest afford our gardeners most delight; it is from these that artificial or cultivated varieties can most easily be produced. There are many thousands of cultivated varieties of the rose, in fact, so many that it would not be possible to make a complete list. All these have been produced from a comparatively small number of wild species, by artificially fertilising the flowers of some plants with the pollen from others, and by selecting the plants which produced the most beautiful blossoms.

In Nature, the pollen from the flowers of one plant is carried to those of another by the wind and by insects, and selection is accomplished by the survival of those plants which can adapt themselves to the conditions due to competition with other plants, to the varying conditions of soil and temperature, and other circumstances of their environment. Some plants develop characters which enable them to live in water, and thus to avoid competition with land plants. Others secure an abundance of light and air by developing woody stems; raising themselves above surrounding vegetation. Climbing plants accomplish the same end by developing long climbing stems, by transforming their leaves into tendrils, by producing modified rootlets, and similar means; clinging to trees or other objects for support.

It is clearly an advantage to plants to scatter their seeds, for if confined to a small area they would die out through exhaustion of the soil and other causes. Hence we find plants provided with devices for this purpose. In some the seed capsule when ripe bursts open with sufficient force to send the seed to a distance; the fruit of others is provided with hooks and spines, attaining the same end by clinging to passing animals. Some fruits and seeds have wings or feathery processes, and are carried by the wind. Those fruits which we know as berries are eaten by birds and animals, but the seeds having hard indigestible coats or shells, ultimately reach the soil uninjured.

All plants when examined under the microscope will be found to be built up of innumerable little bodies called cells, and every plant is developed from a single cell, which may be called the mother cell, contained in the ovule or young seed. It is doubtful if a botanist could forecast what plant any particular mother cell would develop into, without previous knowledge as to the plant it was derived from. We have yet to learn what natural force or combination of forces causes these mother cells to develop into such different forms of life, the perfect plant always inheriting most of the characters of its ancestors, yet differing from all other plants in some respects.

Our chemists and physicists tell us that the chemical and physical phenomena accompanying organic life are in every respect the same as those accompanying changes in inorganic matter; yet our present knowledge entirely fails to explain the phenomena by which we recognise living or organic matter from dead or inorganic matter. We are still quite ignorant as to what inherited force, or forces, cause such minute bodies as the mother cells of the oak and daisy to develop, the one into a giant tree, the other into a humble herb. All naturalists accept Darwin's teaching that both are the result of a gradual evolution brought about by natural selection, and the survival of the fittest; this, however, leaves much to be explained.

The next large group of British plants is the Pink family, but we must first deal with some smaller groups. The most interesting of these is the

Violet Family (*Violaceae*),

and, perhaps, the most interesting member of this family is the

Sweet Violet (*Viola odorata, Lin.*).

The name violet formerly included other sweet-scented plants, but this has always been a favourite. In "Paradise Lost" we read,*

> "Iris all hues, roses, and jessamin
> Rear'd high their flourish'd heads between, and wrought
> Mosaic; under foot the violet,
> Crocus and hyacinth with rich inlay
> Broidered the ground, more coloured than with stone
> Of costliest emblem."

Shakespeare alludes to the violet no less than twenty-seven times:

> "Violets dim,
> But sweeter than the lids of Juno's eyes
> Or Cytherea's breath."†

It is considered unlucky in Worcestershire to take less than a bunch of violets or primroses into a farmer's house. The neglect of this rule is supposed to bring disaster to his brood of young chickens. It was formerly believed that if roses and violets flourished in the autumn an epidemic would occur during the following year.

The deep blue colour of the violet would lead us to expect a highly developed specialisation, and, in fact, the flowers are adapted for insect fertilisation only, but they flower very early in the year; insects are, therefore, apt to fail them. They are, however, provided with another kind of flower, in which the petals are absent or imperfectly

developed, and the stamens are also small, but contain some pollen. These imperfect flowers (cleistogamic) are developed abundantly in the autumn. They never open, their stigmas being fertilised by the pollen contained in the closed flowers. The petals of the violet often relapse into white, a more primitive colour; the bases of the petals then usually retain a purple tint. When the soil in which the plants are growing is sufficiently loose the violet forces its seed vessels into the ground, thus planting its own seed. Ants, however, carry the seeds to their nests, thus often securing for them a wider distribution.

The roots of the sweet violet are carthartic and emetic. A syrup made from the petals still finds a place in medicine, both for colouring and for its emetic qualities.

In the

Hairy Violet (*Viola hirta, Lin.*)

we have a near relative of the sweet violet. This plant also thrusts its seeds into the ground, but the next plant, the dog violet, raises its capsules high, and when the seeds are ripe ejects them to a considerable distance. Lord Avebury suggests that these two different modes of depositing their seeds have arisen through the different places of growth of the two plants. The sweet violet and the hairy violet are hidden amongst the herbage, in a wood or in a hedge, and their flowers have very short stalks, but the dog violet has a very long stalk which easily rises above the herbage of the open heath on which it grows, and can, consequently, scatter its seed far and wide.

* Book IV. † Winter's Tale IV. 4, 120.

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The Dog Violet (*Viola canina, Lin.*)

occurs in open pastures and upon heaths, though the name is often given to a violet common in our woods, and which is more properly called wood violet. The dog violet is variable in size, habit, and in the colour of its flowers. This plant is also provided with flowers which do not open, and in which the petals are reduced to mere scales. The stamens of these (cleis ogamic) flowers are very small and do not cohere as those of the perfect flowers do. They have no vestige of the honey gland, which, in the perfect flowers on the same plant, secrets honey. The pollen grains of these have very thin coats and shrivel quickly if exposed to the air. Whilst they are still in the anther these grains emit a tube at their upper end which finds its way to the stigma. The stigma is provided with an enlarged funnel-shaped extremity to its style; this is covered by the anthers, and affords a passage to the ovarium. Darwin found that the perfect flowers of this plant only occasionally produced seed when visited by bees. The manner in which this plant raises its seed vessels and disperses its seed has already been described. It has been known to eject its seed as far as ten feet.

The Wood Violet (*Viola sylvatica, Fries.*)

is often called the dog violet. It occurs in thickets and on hedge banks. Its flowers secure more insect visits than any of its relatives. Its lower anthers are provided with spurs, which act as honey glands, and the hollow spur at the base of the lower petal receives the honey secreted. An insect when inserting its proboscis into the flower presses a liplike valve. This prevents pollen entering the stigmatic chamber, but on entering another flower it leaves some pollen upon the valve, thus effecting cross-fertilisation. The perfect flowers of this species produce more seed than any other species of the same genus.

The Pansy (*Viola tricolor, Lin.*)

is also a violet, though, owing to the petals being flattened out, and to its different colour, one would not at first sight recognise this as a violet. It has received many popular names, such as Heartsease, Herb Trinity, Paunce, Love in Idleness, or, perhaps, more correctly, Love and Idle, *i.e.*, in vain:

"When passions are let loose without a bridle,
The precious time is turned to love and idle." *

In Shakespeare we read of love in idleness,

"But see, while idly I stood looking on,
I found the effect of Love in Idleness."†

It is called herb trinity from its having three colours in one flower. Its name, heartsease, originally meant "content," and the name, pansy or paunce, is for thought,

"And there is pansies—that's for thoughts."§

The pansy hangs down its head at night, thus protecting its young flower from cold and wet. It is a good example of the tendency in flowers with highly variegated colours to be very variable, and, consequently, much prized by florists. Both the stamens and pistil are apt to become petal-like in character.

The Milkwort Family (*Polygalaceae*)

is the next small group, and is represented in England by two very rare species and one very common species. The latter,

the Common Milkwort (*Polygala vulgaris, Lin.*),

is also known as Procession Flower, Rogation Flower, and other names. Bishop Kenet describes it as a flower in prime in Rogation week, of which the maids make garlands and use them in those solemn processions. Gerard says that "the maidens who used in the country to walk in procession made themselves garlands and nosegays of it."

This little plant with its racemes of small flowers, folded in the bright blue and pink inner sepals, which form wings lying flat upon the fruit after flowering, is too characteristic to be confused with any other British flowering plant. Allen says of it: "Sometimes, indeed, we may say that the new colour has not yet begun to fix itself in the species, but that the hue still varies under our eyes. Of this the milkwort forms an excellent example, for it is occasionally white, usually pink, and frequently blue; we may regard pink as its normal colour, white is doubtless a reversion, and blue a progressive modification." *

The plant occasionally produces flowers which fertilise themselves without the flower bud opening (cleistogamic). The roots, when bruised, give a very characteristic odour of wintergreen, said to be formed by the decomposition of a glucoside (gaultheria) under the influence of an enzime.

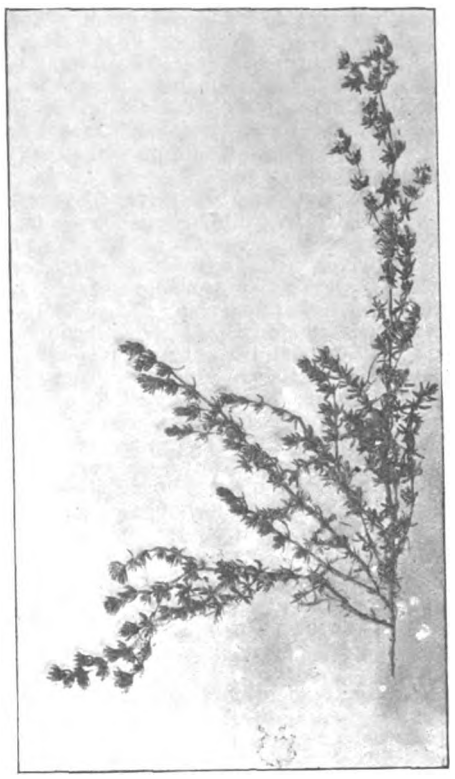
Another very small family is the

Frankenia Family (*Frankeniaceae*).

It is represented in England by one plant, the

Sea Heath (*Frankenia laevis, Lin.*),

which is both inconspicuous and rare. It grows upon maritime sands.



Crystals of salt may be observed upon its leaves, which are secreted from their substance, in the same way that a coat of lime is secreted by some saxifrages. To the naked eye the plant has a punctated appearance. It is evident that corresponding to each dot there is a little cavity, the deepest part of which is constituted of cells with extremely thin walls. In quite young leaves only a single cell of the kind is seen at the bottom of each shallow depression, but this divides, and by the time the leaf is full grown three or four cells will be seen to have arisen out of this one cell. Stomatae also occur near these depressions. In rainy weather a watery juice exudes, which contains much salt, and crystals are found in dry weather; these absorb the dew at night, when the crystals disappear. This absorption of moisture is doubtless of service to the plant.

Heredity and Education.

A RATHER charming illustration is given in a letter by Sir Samuel Wilkes in a recent communication to the *Lancet* in which he endeavours to enforce the view that hereditary tendencies may be corrected in children by their surroundings. "I may mention one particular instance of the influence of sun and air by an example always before me. When I came to my present residence two years ago there grew a handsome plane tree close to the back of my house; as it shut off the light and warmth from the room, I determined to sacrifice it. When it was cut down I had a slice taken from the trunk a few feet from the ground. On examination of the section, the usual centre or pith was quite away from the true centre, being placed on one side, and then on counting the annual rings I found that in a corresponding manner they were much narrower at the smaller side than on the other. This narrow side represented the part of the tree next the house, the broader expanded part was that which looked out into the garden and received the warmth of the sun and more air. This specimen, which is before me on my desk, is always preaching to me the lesson of the importance of surrounding influences; that all living things are dependent for their characters on two things—their hereditary tendencies and their actual surroundings. In the human being the latter may be called education."

*Taylor. † Taming of the Shrew. I. 1. 155. § Hamlet IV. 5, 176.

* Colours of Flowers, Grant Allen, 1891, p. 73.

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Electrical Notes.

Firemen and Live Wires.

A NEW danger has been added to the fireman's calling by the existence of electric wires carrying high tension currents. The danger is not extreme in Great Britain, where, except in the case of the overhead wires of trolley-system tramways, most currents of high tension are carried underground; but on the Continent and in America this is far from being the case, and the saving of expense encourages rather the conveyance of currents of the highest tension on overhead wires. Such wires sometimes bar access to a burning building, and the fireman who has to chop them away is confronted often by an extremely dangerous task. But a more peculiar danger than this exists, which is that the water from the nozzle of the fire-hose that the fireman holds in his hand may, if the high tension wire be near enough, convey a shock to him. It has to be very near, of course, but it has been thought worth while in Germany to make exact experiments to ascertain dangerous distances. From a live wire carrying a 6000-volts alternating current, a shock will be felt along a little more than twelve inches of the stream of water. If, however, there is soda in the water, as sometimes is the case in apparatus designed to extinguish fire by creating fumes of carbonic acid, the shock can be imparted to the fireman along more than a yard of water stream. With a direct current of 550 volts, which is about the voltage of a tramway line, the nozzle must be as little as three inches away.

Earth Leakage Wireless System.

A new system invented by two Alsatians for the transmission of electrical impulses without wires through the earth consists in both poles of an electric-current conductor being connected to the earth, whereby an electrical induction field is set up around each pole, the extent of which depends on the intensity of the current employed. In each of these two induction fields it is possible to utilize the electrical impulses produced at the place of generation by the introduction of two poles at suitable points within one of these fields. Relays, such as are well known in telegraphy and telephony, may be employed in order to transmit the electrical impulses over a wider area, these being connected to the two poles and their resulting currents being used to generate further fields. The inventors claim to transmit by means of their system telegraphic, telephonic, or any other desired electrical impulses, the transmission not being subject to outside influences, such as bad weather, storms, &c.—factors which render the wireless transmission of electrical impulses through the air more or less unreliable.

Steam v. Electricity.

Some time ago an elaborate article appeared in the *North American Review* to show that the conversion of the trunk lines of American railways from steam to electric traction would result in an immediate profit, even allowing for the interest on the capital required to be sunk. The profit was to come chiefly from economy in working. A rather pertinent instance is to be found in the recently-published accounts of the elevated railroad in New York, the economical conversion of which to electric traction presented more difficulties than in the case of trunk lines. In the first quarter's working the cost has fallen from £280,000 to £260,000, a saving of £20,000; and meanwhile the earnings have risen from £571,000 to £654,000. The total gain for three months is therefore over £102,000. The chief reason of the increased earning power is the increased speed of the trains, which is about 25 per cent.

Electric Peculiarities of the Diamond.

Specific gravity, hardness, and quantitative composition with oxygen have hitherto been held as the necessary requisites for the certain identification of the peculiar properties of the diamond. Very recently Mr. A. Artoin, of Turin, proposed that a number of electric phenomena, of which some appear quite characteristic, be added to the distinguishing features above referred to, as in a measure complementary and of equal importance. The specific electrical resistance of the diamond is about the same as that of ordinary glass; it lies, according to the values calculated by Artoin, somewhere between $0{\cdot}2$ and $1{\cdot}3 \times 10^{12}$. Worthy of note is it that graphite, the allotropic form of carbon, in which the diamond is transformed under very high temperatures, possesses 10^{15} times as great a conductivity. Subjected to the Röntgen rays, the conductivity of the diamond is increased twofold, only to be reduced to its original capacity immediately upon the removal of the beam. Like ice, the diamond also possesses a dielectric constant, which is much greater than would be expected from its exponent of refraction (relatively here, the dielectric constant K = the square of the exponent of refraction N^2). Theoretically, it ought to be 7; in reality, however, it lies somewhere between 10 and 17. This may be taken to indicate that the diamond, as is the case with ice, retains the dielectric constant of a former fluid state after it has become solidified. Meanwhile, it is possible that certain hydrocarbons, such as CH_2 and CH_3 are present in small quantities in the diamond, and to them is ascribable the augmentation in the dielectric constant. The diamond, too, discloses a certain amount of permanent polarization and electric hysteresis. Besides, it is very weakly para-magnetic and pyro-electric.

An Electric Roller.

An electric embankment roller has been employed in consolidating the dam of the Grosbois reservoir on the Bourgogne Canal in France. Steam rollers were not adopted for the purpose because of the difficulty of transporting them to the site and of obtaining fuel for them. On the other hand, a water power was easily developed for running a small generator furnishing all the current needed for this roller and also for pumping. The machine had three grooved wheels 3½ feet in diameter, one in front, which was used in steering in the usual manner, and two in the rear with a single fixed axle. The axle carried a large gear which was driven by a worm on the extension of the armature shaft of an 18-horse power motor. By means of a resistance box the speed of the roller could be varied between one and four miles an hour. The current was delivered by a pair of wires on which ran trolleys connected by flexible cables with the roller. Current at 250 volts was used. The roller weighed 7,700 lbs., or about 115 lbs. per inch length of the rolls. The compression attained with this machine is reported in the Nouvelles Annales de la Construction as 30 to 35 per cent., which is incomprehensible. The earth was spread in layers a trifle less than three inches thick, and consolidated by twelve to fifteen passes of the roller.

Natural History Notes.

The Chambered Nautilus.

MR. THEODORE ANDREA COOK, the author of "Spirals in Nature and Art,' (John Murray) writes to us:—

"To the paragraph on 'Poets and the Nautilus,' I should be tempted to add that Oliver Wendell Holmes used Nautilus Pompilius (not, of course, Argonauta Argo) in one of the finest similes ever written on a shell. A section of N. Pompilius is now before me. But though the poet wrote:

> Wrecked is the ship of Pearl,
> And every chambered cell
> Where its dim dreaming life was wont to dwell,
> As the frail tenant shaped his growing shell,
> Before thee lies revealed
> Its irised ceiling rent, its sunless crypt unsealed. . . . .

he did not examine his section with sufficient care in developing a splendid imagery in which biological accuracy was very properly his last consideration. For the point of his simile is that each compartment in which the creature successively lives is larger than the one before it. But the last one, in every Nautilus and Ammonite, instead of being the largest of all, is distinctly smaller than the one before it; a very pretty instance of Nature's beautiful asymmetry which may, perhaps, be explained by the results of increasing age on the inhabitant of the shell.

"Nautilus Pompilius presents another valuable point of interest to scientific workers, inasmuch as it first suggested to Sir John Leslie the organic aspect of the curve-line known to mathematicians as the logarithmic or equiangular spiral. In 'Geometrical Analysis and Geometry of Curve Lines' (Edin.: 1821, p. 438), he pointed out that 'this spiral exactly resembles the general form and elegant septa of the Nautilus.' Canon Moseley (Phil. Trans. 1838, p. 351) continued this idea further by making an exact geometrical examination of certain Turbine shells, with very beautiful results; and Mr. Church, of Oxford, has further applied the logarithmic spiral (as an ideal formula for 'uniform growth') to phyllotaxis.

"The whole question raises a most interesting consideration as to the unknown factors in natural growth. The poet is, of course, not much more inaccurate in the metaphors and similes of his unscientific imagination than is the mathematician in those calculations, for expressing natural objects in a formula, which must invariably be baffled by this unknown factor. But it is, perhaps, unfortunate for the highest interests of science that the natural object which has attracted both the poet and the scientific inquirer, from very different points of view, should apparently never have succeeded in bringing them a little more closely into relation—or sympathy—with each other."

The Changing Chameleon.

Perhaps the most extraordinary of all the members of the Lizard tribe is the Chameleon, of which there are nearly twenty distinct species.

This reptile enjoyed a reputation among the ancients, somewhat ill-deserved as modern investigations prove, of being able to assume almost all the colours of the rainbow, and it was commonly believed that these hues were not only a result of propinquity to some coloured object, but were also changed at the will of the Chameleon itself.

As a matter of fact it has been proved that the changes of colour are in reality very slight, and although it is known that the colours vary when the reptile is excited or angered, it is probable that these effects are due to the greater or less rapidity of circulation. Mr. Milne Edwards is of opinion that they are caused by two layers of pigment cells which move one upon the other and so produce the varying tints.

Dr. Weisenbaum, in the "Magazine of Natural History" for 1838, says:—

"The remote cause of the difference of colour in the two lateral folds of the body may be distinctly referred to the manner in which the light acts upon the animal. The statement of Murray that the side turned towards the light is always of a darker colour is perfectly true; this rule holds good with reference to the direct and diffused light of the sun and moon, as to artificial light. Even when the animal was moving in the walks of my garden and happened to come near enough to the border to be shaded by the box edging, that side so shaded would instantly become less darkly coloured than the other.

"Now the light in this way seldom illumines *exactly* one half of the animal in a more powerful manner than the other, and as the middle line is constantly the line of demarcation between the two different shades of colour, we must evidently refer the different effects to two different centres, from which the nervous currents can only radiate, under such circumstances, towards the organs respectively situated on each side of the mesial line.

"Many other circumstances may be brought forward in favour of the opinion that the nervous currents in one half of the Chameleon are going on independently of those in the other; and that the animal has two lateral sides of perception, sensation, and motion, besides the common one in which must reside the faculty of concentration.

"Notwithstanding the strictly symmetrical construction of the Chameleon as to its two halves, the eyes move independently of each other, and convey different impressions to their different centres of perception; the consequence is that when the animal is agitated the movements appear like those of two animals glued together. Each half wishes to move its own way, and there is no concordance of action. The Chameleon therefore is not able to swim like other animals; it is so frightened when put into water that the faculty of concentration is lost and it tumbles about as if in a state of intoxication. On the other hand, when the creature is undisturbed, the eye which receives the strongest impression propagates it to the common centre and prevails on the other eye to follow that impression and direct itself to the same object."

Sleep and Sloth.

Another strange feature of the Chameleon is its power of "sleeping with one eye open." That is one side of its dual organism may be awake and the other asleep. To again quote Dr. Weisenbaum: "When cautiously approaching my specimen at night with a candle so as not to awake the whole animal by the shaking of the room, the eye turned toward the flame would open and begin to move, and the corresponding side to change

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colour, whereas the other side would remain for several seconds longer in its torpid and changeable state with its eye shut."

The Chameleon has abnormally large lung provision, and some naturalists advance the theory that its power of inflating its body accounts for the changing colours. The body is rendered semi-transparent, and the colour of the object upon which the animal is resting is seen through the translucent skin. It was from this power of inflation and the fact that the animal can exist for some months without taking any food at all that the ancients derived their fable that the Chameleon lived upon air.

The tortoise has always been considered somewhat leisurely in his movements, but his pace becomes positively rapid when compared with that of the Chameleon, whose movements are characterised by the most extreme deliberation and caution. It is to this sluggishness and its faculty of assuming the colour of the leaf or twig upon which it rests that the Chameleon manages to escape total extinction, for as a French writer has remarked "un Chaméléon aperçu est un Chaméléon perdu." Its absolute immobility renders it difficult of detection, whereas a little more activity would betray it to the lynx eyes of its numerous enemies.

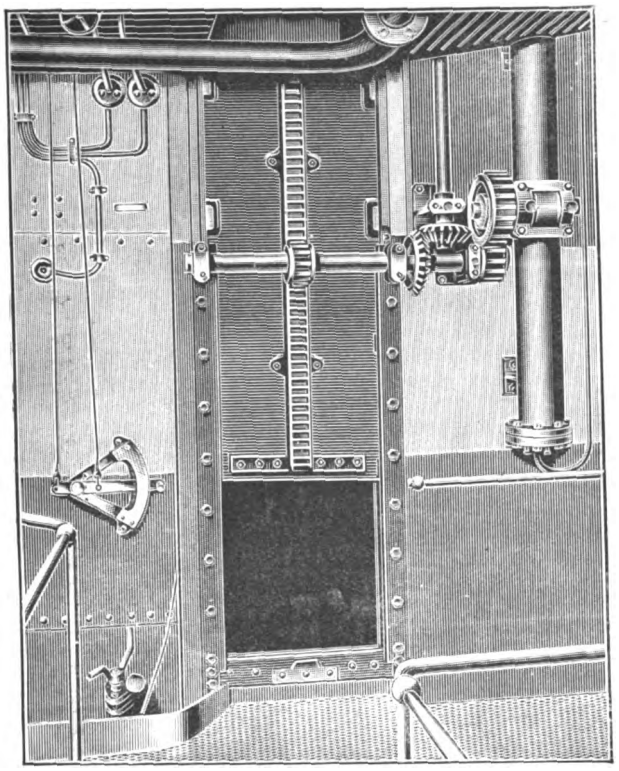
Its lengthy fastings also may be traced to this same laziness. It is too much trouble to eat, so the Chameleon goes without.

One observer of the habits of this animal mentions the fact that on being offered a live fly it to all appearance swallowed the insect. Some time after, on being offered another, it slowly opened its mouth and the first fly walked out alive and uninjured!

Automatic Closing of Bulkhead Doors.

The Stone-Lloyd System.

IN the official Admiralty minute on the loss of *H.M.S. Victoria*, which foundered with appalling loss of life after being rammed by the *Camperdown*, it was stated "that. . . . before the collision took place, a large number of watertight doors, hatches, and ports were open, and that owing to the inrush of water, many of these, situated in the forward part of the ship, could not afterwards be closed. . . . Investigation shows that while the loss of buoyancy must have been considerable, yet



The Hydraulic Bulkhead Door.

making all due allowance for probable damage, the ship would have remained afloat, and under control, and able to make port under her own steam." The case of the loss of the *Victoria* has been only too frequently repeated, and as instances which have tended to accentuate the need for the effective closing of water-tight compartment doors may be reviewed the foundering of the *Drummond Castle*, the *Stella*, or the *Elbe*, in each of which cases the vessel would doubtless have been saved, together with the hundreds of souls which perished in these disasters, had there been any ready means for closing the bulkhead doors. These means have now been rendered possible by the invention of a Scotsman named Ralstone, and in the "Stone-Lloyd" system, as Mr. Ralstone's invention is known, the bulkhead doors of the water-tight compartments are simultaneously closed by hydraulic power. Messrs. J. Stone and Co., of Deptford, manufacturers of ships' fittings, are the patentees, and their system has been successfully fitted to the largest and fastest mail steamers of the Norddeutscher Lloyd line, and an installation is also at work on the Hamburg-American liner *Deutschlamd*. Briefly described, the system consists of water-motors or cylinders geared to the bulkhead doors, which are worked vertically. These cylinders are supplied with hydraulic power from four large accumulators, of sufficient capacity to supply pressure at 500 to 700 pounds per square inch. For working the twenty-four doors below the water-line there are two sets of accumulators, port and starboard, which are charged by two sets of duplex long-stroke pressure pumps, supplied with steam from the main boilers, and these pumps are always working at a slow speed. The mode of closing the doors is as follows: After a collision, or other emergency, the officer on the bridge of the ship operates a small lever, which sounds electric warning gongs placed over the various doors. When the gongs cease the doors automatically and simultaneously descend, with sufficient force to crush their way through four or five feet of coal in a trolley, supposing this to be the obstruction. One of the chief features of the new system, however, lies in the fact that it ensures a ready means of escape to any of the crew who might be imprisoned behind a closed door, and who would otherwise be compelled to drown like rats in a trap. By means of a small handle, a member of the crew who is shut up in a flooded compartment can make his escape by opening the door which affects him, independently of the others, and when he has passed through, the door will fall again The mechanism for operating the doors is supplemented by Stone's patent automatic bilge float valve, which closes the doors of compartments on an inrush of water on either side of the ship.

Water power was chosen as the actuating force in preference to either steam, electricity, or compressed air, on account of its simplicity of working, and docility. As the dividing of ships of great tonnage into many water-tight compartments has been proved to render them practically unsinkable, Messrs. Stone's system should prove an effective solution of the bulkhead door-closing problem; and although, so far, the English companies have not adopted the invention, it is to be hoped that the example of the German lines will have a salutary effect on British shipbuilders, for the increased mental comfort to passengers—who only naturally prefer to travel in "unsinkable ships"—should be very great.—C. H.

Temperature in Mines.

ON the Rand mines the question of increase of temperature with depth is a matter of importance in their future development. The Witwatersrand beds, it is hoped, will be favourable to mining at great depths, for its elevation above sea level is nearly 5700 feet, so that the deepest mining projected on that area will not be down to sea level for some time to come. A number of experiments in boring have been made, and from them it is hoped to obtain actual knowledge of the temperature down to 5000 feet; and some calculations have been made, based on the temperature of borings already examined, of the probable temperature down to 8000 feet. Compared with the ascertained increase of temperature in English coal mines, they appear to be far from exaggerated. At 1000 feet the temperature of the rock is taken as about 69 degs. At 3000 it rises to 78 degs., and at 4000 to 83 degs. At 5000 the engineer's estimate is 88 degs., at 7000 it should be 97½ degs., and it is not till 8000 feet is reached that an estimated temperature of over 100 degs. is anticipated. It is also said that the temperature should diminish by about 10 degs. after connections are made; an expectation which strikes me as optimistic.

In the evidence given by Mr. J. Dickinson before the Coal Commission, some instructive particulars were given of the increase of temperature in mines at increasing depths. At the Rosebridge Colliery, Wigan, the temperature of a seam newly sunk to a depth of 2,391 ft. was 93·5° F.; in a seam of the Pendleton Colliery, Manchester, a temperature of 83° F. was taken at 2,088 ft.; and at the Moss Colliery, Ashton-under-Lyne, a seam at 2,520 ft. gave a temperature of 81° to 84°. These figures indicate variations in the rate of increase of temperature with depth; and Mr. Dickinson pointed out that the same peculiarity is noticeable in the temperatures ascertained by deep-sea soundings, which, according to the observations taken in laying the recent all-British cable, sometimes are found to decrease at great depths. Mr. W. N. Shaw, F.R.S., recently mentioned an allied phenomenon in the temperatures of the upper air. Possibly with increased depth in coal strata some corresponding limit of increasing temperature may be reached, or the ratio of increase may become smaller. Mr. Dickinson also mentioned that the coal seams were hotter than the surrounding rocks. As a rule all coal workings have a warmer atmosphere than ironstone workings at the same depth. Sometimes after the seam has been struck it cools down.

Deaths by Snake Bites.

THE really frightful mortality caused among the natives of India as the direct result of the bites of venomous snakes seems to call for more attention. During last year, according to the official reports, no less than 23,166 persons actually lost their lives from this cause. These are appalling figures, showing casualties greater than those accruing from a large war. When we go on to read that only 3,529 rupees, some £235, was expended in the destruction of snakes, the ordinary humanitarian may well be surprised. The number of snakes reported killed is 72,595.

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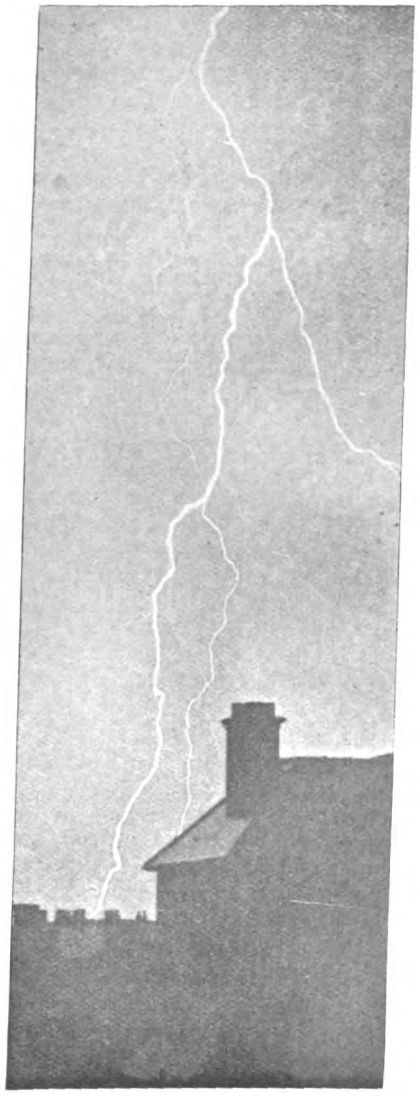
Lightning Flashes and their Spectra.

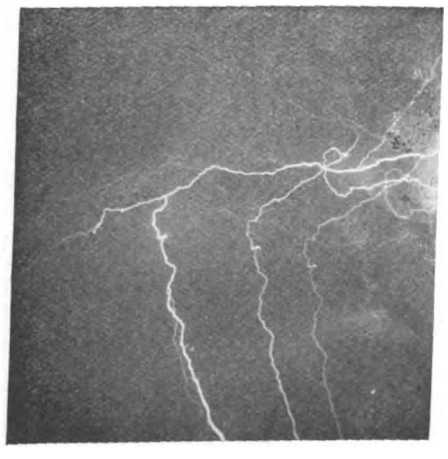
By DR. W. J. S. LOCKYER.

FROM time immemorial dwellers on this planet have had many opportunities of witnessing the magnificent displays which a thunderstorm



Ordinary Lightning Flash taken at Westgate-on-Sea on August 5, 1899, by William J. S. Lockyer.

affords when Nature seems to be turned loose for a time. The storms however, which pass over this country are veritable "pigmies" when compared with those that visit tropical regions, yet for all that many of us have felt somewhat alarmed even with these minor types of atmo-

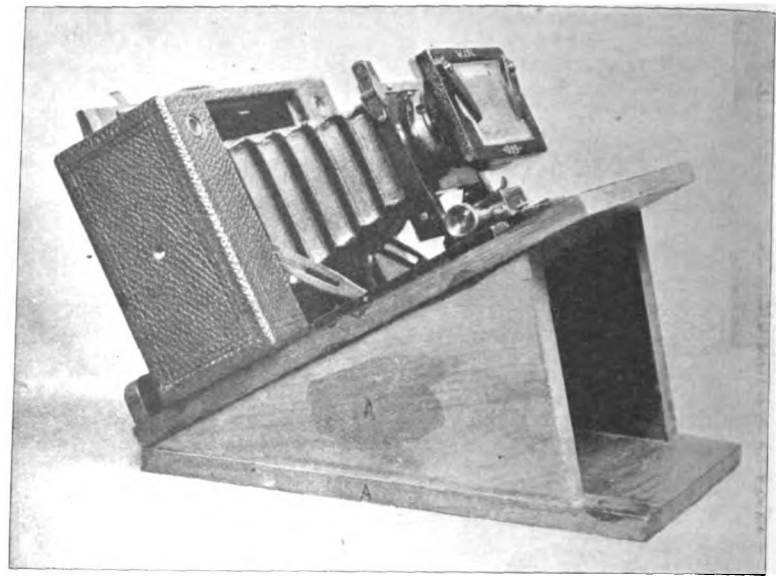


"Multiple" Lightning Flash taken with a moving Camera in July, 1902, by J. P. Wilkie.

spheric disturbances. To observe the full beauty of a thunderstorm a moonless night is the chief desideratum, for then the vivid flashes, which shoot from cloud to cloud or from cloud to earth, can be seen in all their glory, the landscape being lit up with an intensity far exceeding that of the full moon.

The study of these electrical displays forms a subject which is so fascinating and full of interest that at the approach of a storm the idea of fear is forthwith banished from the mind of the student. This is more especially so since the process of photography has been invented, for the keen observer is most anxious to secure a record on the sensitive film, and thus possess a permanent picture, of what previously could only live in his memory.

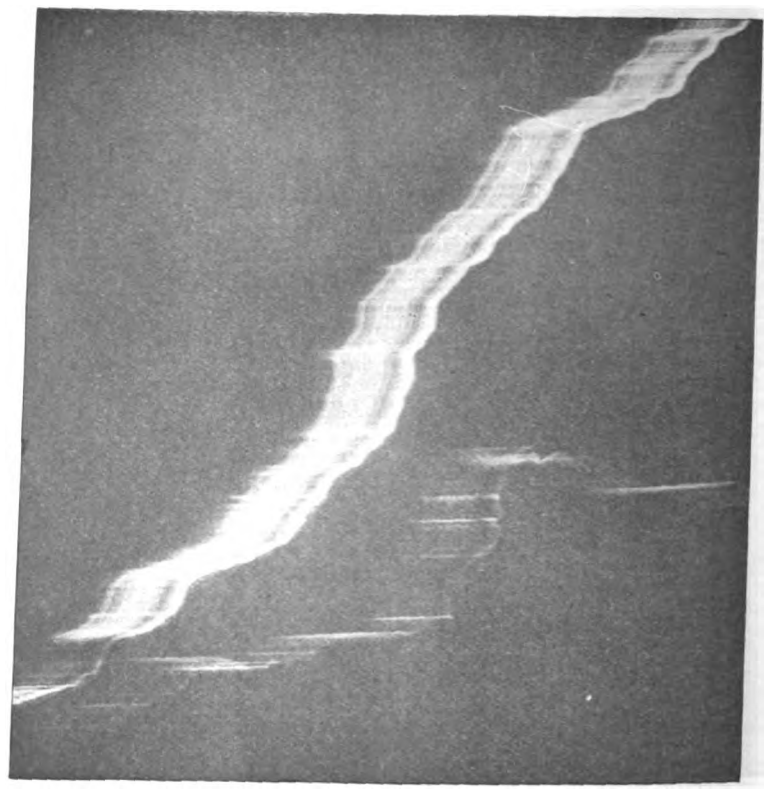
This application of photography has advanced our knowledge very considerably in many ways. We now know, for instance, that a flash of lightning does not pursue a path the form of which was generally described and drawn as "zigzag," but that it more resembles the drawing of a large river with its numerous tributaries on a map. Again, the camera has shown us that flashes have not always the same appearance: thus, some form single streams, while others display a great number of tributaries or "ramifications" as they are termed. The



A 5 by 4 Folding Kodak with a Thorpe Transparent Diffraction Grating, for securing the Spectra of Lightning Flashes, as used by the writer.

form of a "band" is another type which has more than once been recorded, and "multiple" flashes, that is several flashes pursuing at brief intervals of fractions of a second the same path have often been recorded. These facts and others which might be mentioned, all tend to illustrate the variety that is met with in the photographic study of electrical discharges on the scale of Nature.

Provided the thunderstorm occurs at night anyone who possesses a camera, whether it be small or large, can take up this fascinating inquiry. All that has to be done is for the operator to first focus the camera on some distant light or set it to infinity if a scale be attached.



Spectrum of Lightning taken by Prof. E. C. Pickering in America in 1901.

After this adjustment the camera should then be placed in some convenient position, such as a window sill, so that it is protected from the rain and pointed in the direction in which the flashes appear. The insertion of the plate holder, the withdrawal of the slide, and, finally, the taking off of the cap, complete the operation of setting. After one, two, or three flashes have passed across the field of view the plate may be closed and another inserted. In order to record "multiple" flashes the camera during exposure should be held in the hand and oscillated horizontally, the principle being that if the flash is not single then the several images of the flash will fall on different parts of the sensitive

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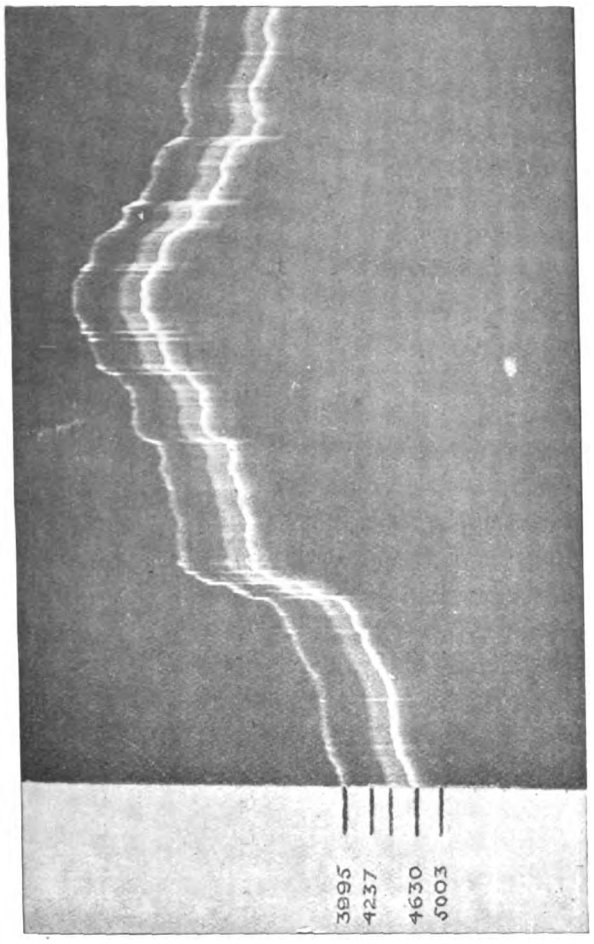
film, their distance apart depending upon the intervals of time between the successive discharges and the velocity of movement of the camera.

There is, however, another piece of research work in connection with lightning flashes which can be accomplished also by means of small cameras, with only a slight addition to them. I refer to the spectrum of lightning flashes.

The scientific value of these spectra lies in the fact that the various elements of the atmosphere, like the various elements of solid bodies under the influence of heat, give off different colours by which they can be differentiated. Thus, hydrogen, which is found in the spectrum of nearly every star, produces a series of well marked lines quite different from those made by such a substance as, say, iron, which is only found in a few stars. It is quite possible then that the spectrum of a lightning flash might teach us much about the constituents of the air of which we are at present ignorant.

It is known that the ordinary electric sparks in air, which can be produced in our laboratories, are, in appearance, only lightning flashes in miniature, as gathered from the great similarity of their forms. When, however, the spark, as artificially produced, is analysed spectroscopically, that is, by allowing the light from it to pass through a prism



Spectrum of Lightning taken by Prof. E. C. Pickering in America in 1903. The positions of the chief Nitrogen Lines are marked at the bottom.

or transparent diffraction grating, it is found that the spectrum that is produced contains lines, the origins of which are chiefly oxygen and nitrogen. Now, what is the spectrum of a lightning flash like? Does it resemble that given by the laboratory spark, or is it quite different? Further, do all lightning spectra resemble each other?

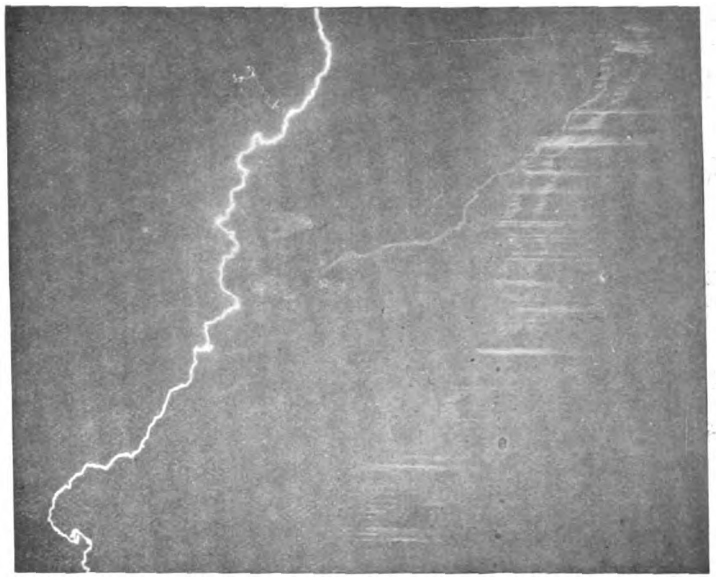
To answer these questions many workers among whom may be mentioned Schuster, Vogel, Kundt, Colonel J. Herschel, and others, have made observations. These attempts were made by means of small and handy spectroscopes, and consisted in trying to locate visually the positions of the lines in the spectra. The difficulty of pointing the instrument in the right direction at the right moment, and the shortness of the time of duration of the flash, rendered the observations so uncertain and few in number that decisive information could not be gleaned.

The general conclusion resulting from such observations showed that the spectrum, in the visible region at any rate, was chiefly due to nitrogen, with the probable addition of hydrogen, oxygen, and carbon, the last mentioned being possibly due to the carbonic acid gas, which is always in our atmosphere. It was noticed, further, that all flashes did not give the same spectrum, some showing bright lines, others bright bands; while others, again, gave a continuous spectrum, that is, a continuous band of light from the red to the violet.

During the last few years photography has been called to our rescue in the solution of these problems, but as yet only a few spectra are available for discussion. The first photographs were obtained in the year 1901 in America at the Harvard College Observatory, while this year the Americans have been again successful; the writer was also fortunate enough this year to secure two photographs during the storm which passed over London on the early morning of May 31.

Even in this class of work large and expensive instruments are not necessary, for the last two photographs referred to above were obtained with small cameras. One of these was an ordinary 5 by 4 Kodak and the other a small Dallmeyer Rapid Rectilinear, each fitted with a Thorpe transparent grating in front of the lens. There is a distinct advantage in using a grating instead of a prism, for, in addition to the spectrum, a picture of the flash itself is secured. Further, it is of importance to know the shape and type of flash that is photographed, since such information is most useful in helping one to decipher the lines in the spectrum.

Owing to the courtesy of Professor E. C. Pickering, the writer is fortunately able to place before the reader reproductions of two of the spectra which he obtained, and he would like here to take the opportunity of expressing to him his best thanks for the same.

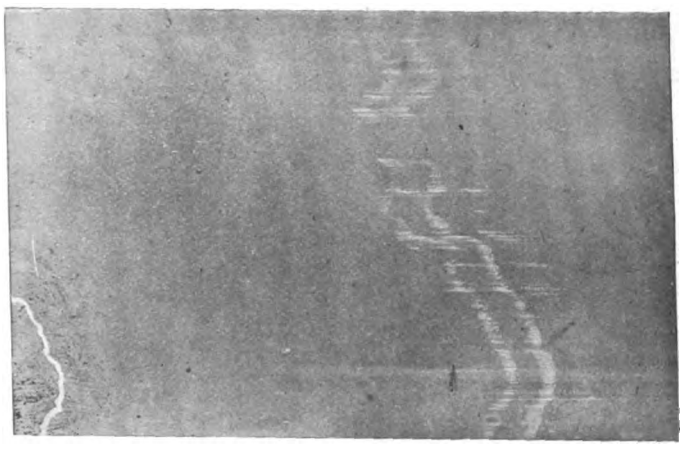


A Lightning Flash and its Spectrum, taken by William J. S. Lockyer in London on May 31 (3 a.m.), 1903. The Spectrum shows two prominent bright lines with a fainter one on the right.

A general glance at all the spectra here shown indicates many differences between them. The American photograph taken in 1901 is different from that secured there this year. Again, both of these are apparently unlike those secured by the writer. Wherein do these differences lie?

It must be borne in mind in the first place that if the flash be not very intense then the spectrum may be very meagre in lines, for only the strongest will be photographed; secondly, if the photographic plates used be not all equally sensitive to the same regions of the spectrum then similarly situated lines will be more dense in one than in another photograph. Again, other differences may arise owing to the various optical qualities of the lenses, prisms and gratings employed.

Apart from these sources of differences there is reason to believe that the spectra already secured are really dissimilar.



Another Lightning Spectrum secured by the writer during the same storm. The Spectrum shows also two strong lines with a fainter one to the right.

The American spectrum of 1901 is, as can be seen, full of lines. Professor Pickering has published a list of their origins. On the assumption that certain lines were due to hydrogen, he suggests that the remainder correspond to those seen in the spectrum of the recent new star in Perseus. This result seemed so remarkable that the writer was prompted to write to Professor Pickering, who very kindly complied with the request, for a copy of the original photograph, to see if it was not possible to reproduce a similar spectrum in the laboratory, that is, to compare it with the spectrum of air from a spark made by means of an induction coil. The spectrum so produced was found to be so tantalisingly similar in general appearance that it was difficult to think that the lightning spectrum could be otherwise than a slight modification of this spectrum.

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The American spectrum of this year is practically that of nitrogen, four out of the five lines corresponding to the principle lines of this gas, so important an element in our atmosphere. Thus the first (reading from left to right), a strong line, is coincident with the nitrogen line 3995.2; the second, a weak line, with 4237.0; the fourth, a very strong line, with 4630.9; and the fifth, a weak line, with 5002.7; the third does not seem to have a corresponding line of nitrogen.

In the spectra secured by the writer the origins of the lines have not yet been finally determined; the difficulty arises from the few number of lines, namely three, photographed. Numerous attempts have been made, using the same instrument and grating, to identify these lines by photographing sparks in air under different conditions, but success has not yet rewarded these endeavours.

Enough, perhaps, has been said to indicate the first fruits of the photographic method, and to give the reader some idea of this interesting and fascinating piece of research. It is hoped that more workers will come into the field and join in augmenting our supply of "raw material," which is so necessary for a full discussion of the subject.

The Electrification of the North-Eastern Railway.

By HERBERT C. FYFE.

THE forthcoming inauguration of the electrical working of the North-Eastern Railway is a very important event in British railway enterprise, because it is the first instance of one of the great railway companies superseding steam by electric traction. It is true that on the Mersey Railway, of which we give some photos, electric trains have displaced the old steam-hauled trains, but this is only a very short line. The North-Eastern Railway is the first to grapple on a really large scale with the problem presented by the steady increase in working expenses and tramway competition. Another point of great interest in this scheme is the fact that Parson's steam turbines will be used *exclusively* in the new power-house at Carville—to drive three-phase alternations, generating current at 5,500 volts.

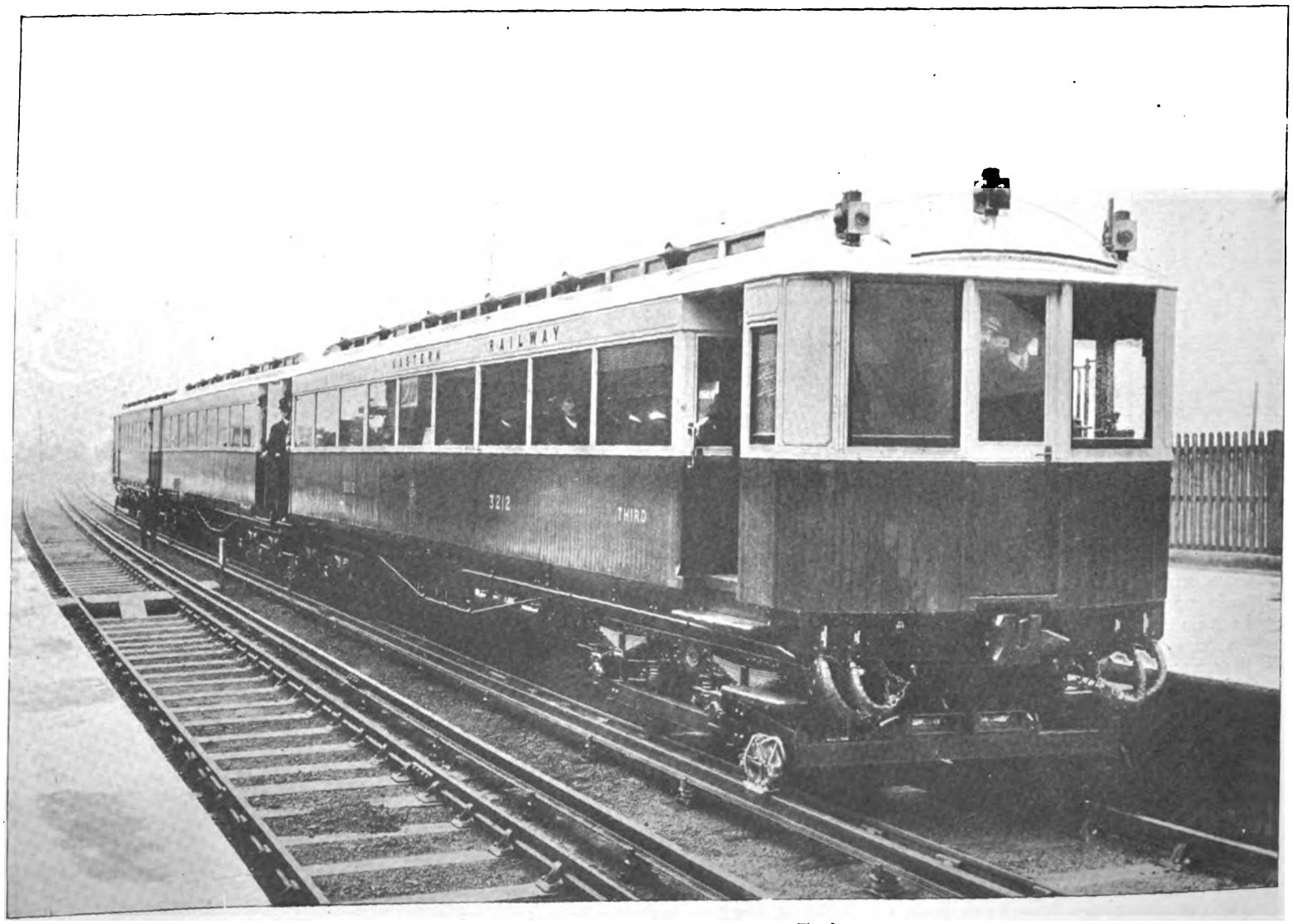
Figure 1 shows the lines which are now being electrically equipped, and also indicates the position of the generating stations and sub-stations which will provide the necessary electrical energy.

The District Served.

The City of Newcastle is situated some eight miles from the mouth of the Tyne, the intervening districts on both banks of the river being densely populated and containing an almost continuous succession of shipbuilding yards and engineering and other works. To the north of the mouth of the river lie Tynemouth and Whitley Bay, which are residential districts in addition to being the favourite holiday resorts for the whole of Northumberland. Between Newcastle and the sea there is, therefore, a large traffic the whole year round and this is swelled to enormous proportions during the holiday seasons. The lines, which are now being electrically equipped for passenger service are at present operated by steam locomotives with the exception of the line from Gosforth to Ponteland, and which is now under construction. The Quayside branch line, which is used for goods traffic only, is also being equipped for electrical operation, the object being, in this case, to overcome the ventilation difficulties which now prevent the line from being fully utilised owing to it being for the most part in tunnel and on a heavy gradient. The engineering conditions to be met present features differing essentially from those prevailing in the electrification of a London tube railway, because some 37 miles of single, double, and four-line track are involved, and there are numerous junctions, crossovers, and other special track work. There is also a very heavy goods traffic to be provided for, which, except on the Quayside branch, will continue, at any rate for the present, to be dealt with by steam locomotives.

A Continuous Current System.

After careful examination of the advantages and cost of various systems it has been decided to operate the trains by continuous current obtained from a single collector rail placed in the six-foot way with a return circuit through the running rails. The current will be derived from rotary converters and static transformers, which convert three-phase current at a pressure of 5,500 volts and periodicity of 40 into continuous current at a pressure of 600 volts. The collector rail will be of special high conductivity steel, Vignoles, section, 80 lbs. per yard, carried on insulators composed of reconstructed granite placed outside the running rail and distant 3′ 11½″ from centre of the track. On double track the separate collector rails belonging to each track will be normally placed between the two tracks, but at junctions, crossings, etc., or wherever there is any obstruction in the six-foot way it can be transferred to the outside of the track as required. At level crossings, stations, etc., the collector rail will be protected by two creosoted boards bolted against distance pieces on each side of the rails. Under normal conditions the collector rail will have no protection, but holes for fixing this are being punched in all the collector



Photographs lent by British Thomson-Houston Co.]

The North Eastern Railway Electric Train.

(Note third rail wheel which supplies the current and the shoe which kicks it up)

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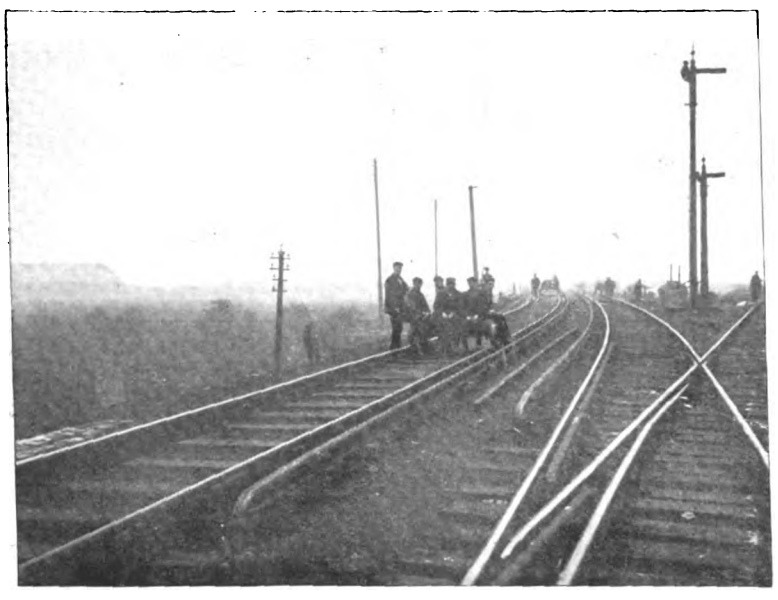
Electrifying the North Eastern Railway.—The Under Frame of a Motor Car.

rails so that protecting boards may be readily applied at any place found desirable. Instead of adopting a second collector rail in the centre of the track for the return current as has been done in some cases it was found that the Board of Trade requirements could be more economically met by bonding the running rails, but the position of the single collector rail has been so fixed that a return collector rail can be installed between the rails at any future time should this prove desirable in the event of great extension of the traffic on these lines.



Electrifying the North Eastern Railway.—A Section of the Line.

Electric Power Supply.

Current will be supplied to the collector rail from five sub-stations located at Pandon Dene, Wallsend, Cullercoats, Benton, and Kenton. Fourteen 800 k.w. rotary converters will be installed, distributed among the various sub-stations so as to best meet the load. The sub-station containing the largest plant capacity will be Pandon Dene, where four of these rotaries will be installed. In order to meet the excessive fluctuations of the load, each rotary has been specially designed to operate without serious sparking at an overload of 100 per cent. for 10 minutes and at an overload of 200 per cent. momentarily. The main static transformers are of the single-phase, oil insulated, self-cooling type. To each rotary converter is coupled a small induction motor fed by a special transformer, and the rotary converter is started up by means of the induction motor until it attains the synchronous speed of the rotary when it is switched into the high tension busbars in the usual way.

North Eastern Railway—At work on the Third Rail.

With a view of simplifying the arrangement of cables and loads inside the substation the high tension switches have been placed along one side of the substation, while the low tension switchboard will be placed on the opposite side of the building. Only the positive loads will be taken to the low tension switchboard, the negative busbar running near the floor behind the switchboard, and the equalising switches being mounted close to the rotaries. The high tension switches will be of the "oil" type, the feeder switches being provided with an automatic reverse current release, and the converter switches with an overload time limit release, all being operated electrically by low tension con-

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tinuous current for which a small battery is provided in each substation. The substations will receive their supply of energy at a pressure of 5,500 volts, three-phase, through three-core, paper insulated, lead covered cables laid solid in wooden troughs along the railways.

Rolling Stock.

The new rolling stock will comprise motor and trailer coaches, the bodies of which will be built by the railway company at their works in York from the designs of Mr. Wilson Worsdell, the chief mechanical engineer. They will be of the open corridor type, lighted and heated by electricity. Each coach will be carried on two four-wheeled bogie trucks constructed by the Brush Electrical Engineering Company to Mr. Worsdell's specification. Each motor coach will be equipped with two G. E. 66 motors, each rated at 150-horse power, both motors being carried on one bogie truck. The unit train will be composed of two motor coaches with one trailer coach between them, this being strengthened when necessary by the addition of another unit train. The motor coaches will have drivers' compartments at one end only, but a master controller will be fitted in the vestibule at the other end also, so that the coach may be driven from this end if necessary. The ordinary stopping train will take about 23 minutes for the journey from Newcastle to Tynemouth, the average speed being about 22 miles per hour including stops. Quick trains running through without stops will reduce this time to 15 minutes. There will be two electric locomotives for the Quayside branch, and these will be equipped in the same way as the motor coaches with multiple unit controller, Westinghouse air brakes, etc. Each locomotive will be capable of starting with and hauling a train weighing 150 tons up a gradient of one in 27 at a speed from nine to 10 miles per hour.

The Large Supply Station.

Instead of constructing a generating station of their own, the railway company will purchase their current from the Newcastle-on-Tyne Electric Supply Co., Ltd. A portion of this current will be generated at the existing Neptune Bank Station at Wallsend, but this station is now nearly loaded up and the Supply Company have in course of erection a larger station situated at Carville about half a mile further down the river, and it is from this new generating station that the bulk of the supply to the railway company will eventually be obtained. The designs for this new station are now completed and the contracts let. The generating plant is to consist of steam turbo generators, each of 3,500 kw., with an overload capacity of 5,000 kw. for two hours, and the order for these has been obtained by Messrs. C. A. Parsons and Co. As the space occupied by such a set compared with that taken up by the boilers necessary to supply it with steam is so small, the usual arrangements of placing the boiler-house parallel with the engine-room has been abandoned, and instead, each turbine unit will have a separate range of boilers running at right angles to the engine-room. Every two ranges of boilers will be combined in one centrally fired boiler-house, and will be provided with independent flues, economisers, induced draught fans, and a short iron chimney.

Contracts have been placed with the following firms:—

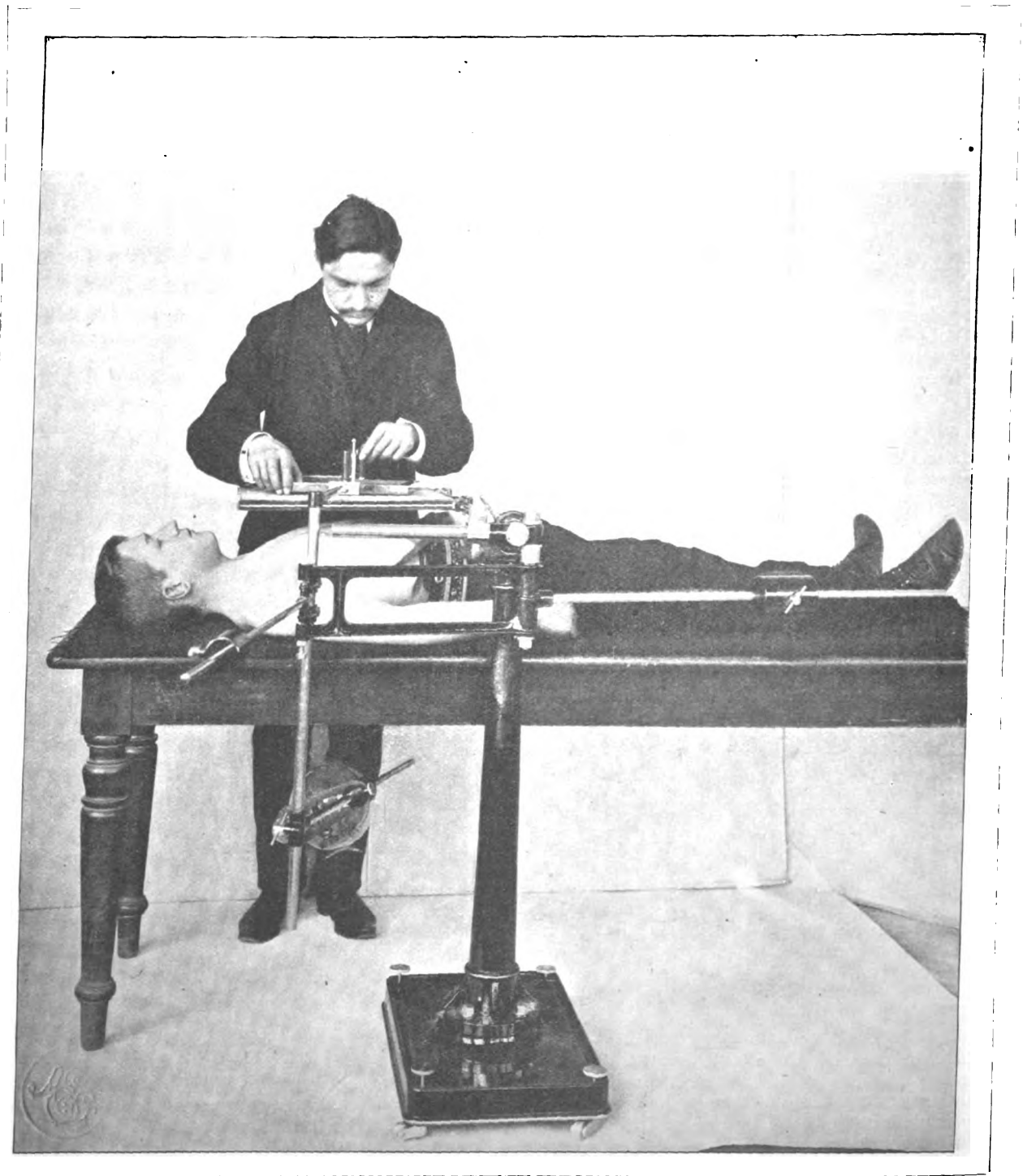
The British Thomson-Houston Company, Limited, electrical equipment of rolling stock and permanent way; the British Westinghouse Electrical and Manufacturing Company, Limited, complete equipment of substations; Messrs. Siemens Brothers and Company, three-phase high tension, telephone, and pilot cables, etc.

The Orthodiograph.

A Novel Rontgen Apparatus.

By DR. ALFRED GRADENWITZ.

RONTGEN rays have, ever since their discovery, been largely employed in medicine in order to ascertain the conditions of internal organs of the human body. In this connection, it is often desirable to obtain graphical records of the shape and size of the latter, and



The Orthodiograph. Ascertaining the exact position of a foreign substance in a human body.

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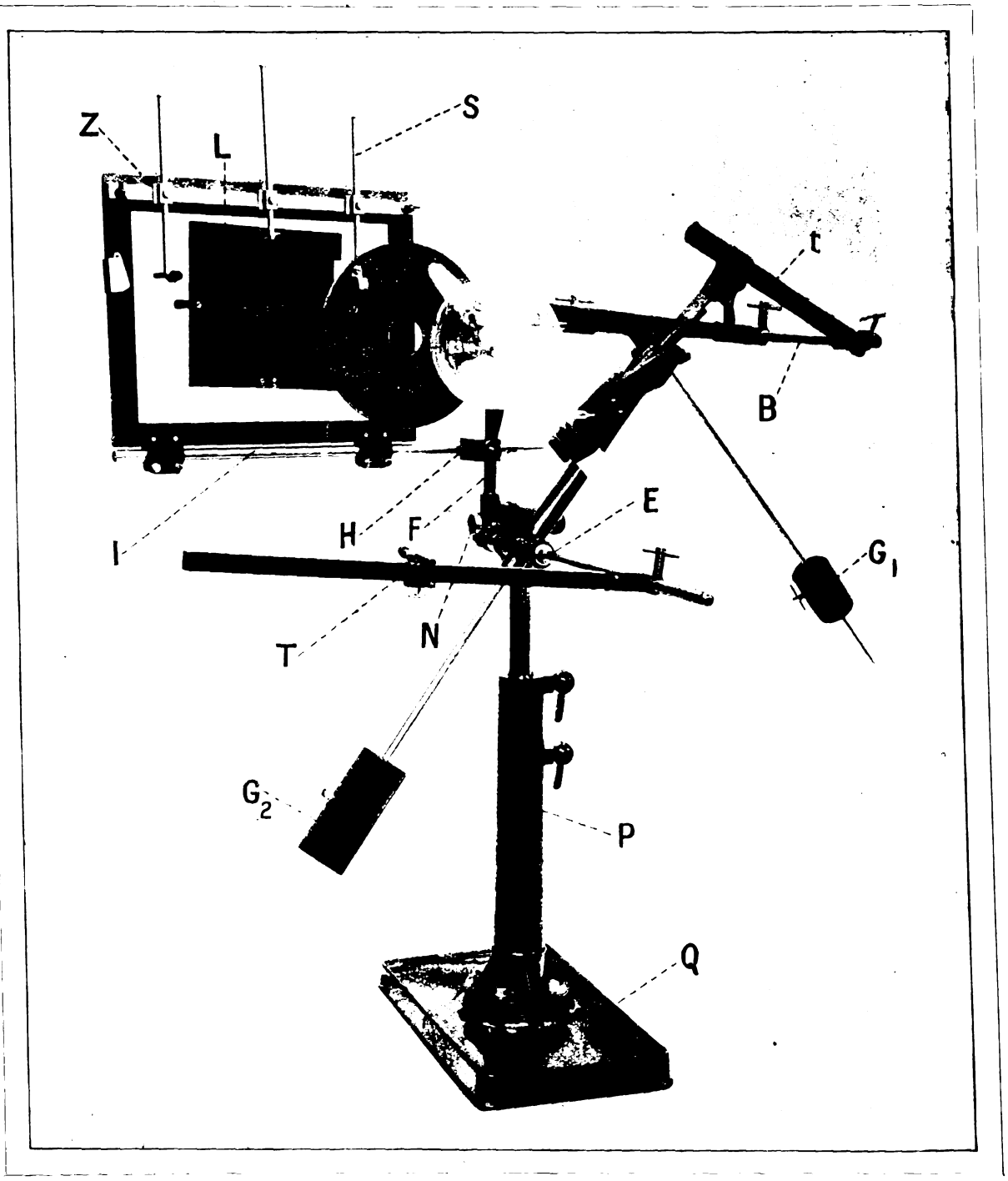
as Röntgen rays are given off from a very small spot opposite the cathode of the Röntgen bulb, radiating from a centre in all directions, the image of a body projected on a luminous screen or photographic plate will be a silhouette, the outline of which coincides with the points where the Röntgen rays touching the body are cutting the screen. This outline, therefore, is the periphery of the base of a cone, the point of which is in the luminous spot opposite the cathode. The image of the object will therefore, in any case, be magnified to a greater or smaller extent, it being impossible to ascertain the true size of the latter but by troublesome and not always trustworthy calculations, apart from rather material deformations.

There is only one possibility for obtaining the record of the object in its true shape and size; the Röntgen ray touching the body and reproducing its outline on the plate will have to be made parallel and to strike the plate at right angles. In other words, the projection from a centre will have to be replaced by parallel projection. Endeavours in this line have been made as far back as 1898; there have even devices been found allowing of such projections being obtained in the case of the object to be projected lying on a horizontal surface. The orthodiograph, just brought out by the Berlin Allgemeine Elektrizitäts Gesellschaft, is free from this restriction, allowing of projections in true shape and size being obtained in any desired position on the drawing plane.

As shown by our illustration, the drawing stylus fixed in the middle of the luminous screen is rigidly connected by a lever system to a Röntgen bulb, the person to be examined being enclosed between these levers. The Röntgen bulb should be so adjusted as to lie in the prolongation of the drawing stylus, when the central ray issuing from the bulb will strike the luminous screen just at the foot of the latter.

Parallel movements in any desired direction, as necessary for obtaining a projection, are effected by the system rotating around two axles parallel to each other, namely, round the pointed bearing D and the axis of the cone E. The drawing frame is placed at a distance of about 1 cm. from the luminous screen and is parallel to the latter. The frame may be fitted with a sheet of paste-board where the records are made by the drawing stylus, along with the luminous screen, moving over the same, while the Röntgen bulb following any movement of the luminous screen and drawing stylus, and always remaining in the prolongation of the latter, will permanently send its central rays through the foot of the drawing stylus. By drawing the latter along the outline of the organ in question, as formed on the luminous screen, the exact shape and size of the latter may thus be ascertained. The length of the column P is such that on turning the system around the axis N into a horizontal position, the drawing plate will just lie at a convenient distance above a man lying on an ordinary table about 80 cm. in height. The heavy base plate Q is provided with four rollers, allowing of the drawing apparatus being readily moved. By operating special screws, the apparatus may be taken off the rollers and placed on the points of the screws, which, in addition, will allow of the column of the apparatus being given an accurately vertical position also on oblique or uneven floors.



The Orthodiograph.

If the apparatus is used for examining a person in a vertical position, the drawing-plate, as well as the column F, should be vertical. If, on the other hand, a record is to be obtained of a person being in a lying or in any oblique position, the column F is turned into the proper position and fixed by acting on a milled nut. Drawing may also be effected immediately on the body, in which case the paste-board is removed from the drawing-frame. In order to be able to draw on the skin a dermatograph stylus should be used as drawing stylus instead of a pencil. There are additional means for accurately marking the position of the person with regard to the central ray, so that, on the examination being repeated, the same position of the person may accurately be secured.

The apparatus allows also of ascertaining the depth of any foreign object contained by the body. To this effect, the above process of recording is combined with a central projection, when a comparison between the apparent and true dimensions of the body will permit of the depth of the latter being evaluated with fair accuracy.

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Continental Physical Notes.

By DR. ALFRED GRADENWITZ.

A Novel Method of Obtaining Electric Waves.

AT the recent Congress of German Naturalists, held in Cassel, Professor H. Th. Simon described a novel method allowing of high frequency alternating currents or electric waves being produced and employed in wireless telegraphy, the underlying principle being analogous to the periodical mechanical phenomena occurring, for instance, in organ pipes where a system capable of oscillating is coupled to a stationary stream, so as to have the intensity of the coupling modified by the vibrations themselves, a maximum being observed in the case of the stationary stream acting in the same direction as the excited stream and a minimum in the opposite case. With experiments, made by the author in conjunction with Mr. Reisch, electric arcs passing between metallic electrodes showed all the characteristics of a similar coupling. By means of high tension continuous currents the experimenters were able to set up highly efficient electric vibrations by means of metallic spark gaps placed in a vacuum, these vibrations being similar to those produced with the Hewitt mercury lamp and high tension alternating currents. The behaviour of high frequency currents is by no means altered through the novel principle. The author considers the usual method of producing electric waves by means of spark gaps placed in the air in connection with induction coils as being irrational, furnishing relatively irregular high frequency currents. As the working condition of a given high frequency system may in each special case be accurately modified according to the explosive distance, the method suggested by Prof. Simon seems to be well adapted for wireless telegraphy purposes.

A New Theory of Magnetism.

In a paper read before the Cassel Congress of German Naturalists, Mr. Zacharias exposes quite novel and somewhat paradoxical ideas as to the nature of magnetical phenomena. According to him, magnetism would be due to *mechanical phenomena* occurring in the ether and attended by a certain more or less high *ether vacuum*. Mr. Zacharias tries to illustrate the mutual action of a magnetic rod and a magnetic needle on the instance of two rotating spheres, one of which is suspended by a thread, and which are found to exert on one another a repulsion in the case of the direction of their rotation being the same, whereas for opposite rotation they are found to adhere to one another.

Some Considerations on the Periodical System of Elements.

In an interesting address delivered before the recent Congress of German Naturalists, Sir William Ramsay points out the fact that the periodical law of elements, in spite of its universally acknowledged importance and value, has so far been refractive with regard to any exact mathematical formulation. As regards the reason of this difficulty met with in establishing simple connections between the atomic weights of elements, there is a possible hypothesis that the weight and hence the mass or inertia is variable, for instance, with the temperature. This hypothesis is, in fact, borne out by some recent experiments by Baily, the results of which are apparently positive. Ramsay then points to Professor Landolt's well-known experiments, where two bodies capable of reacting seemed to undergo during the reaction variations in weight either positive or negative. On the other hand, the irregularities of the periodic system could be due to an inconstancy of the atomic weights, as rendered probable by Miss Aston's not yet published experiments on the atomic weight of nitrogen. Steele's experiments on the molecular weights of gaseous compounds seem also to confirm this hypothesis.

The hopes attached by Ramsay to a research into the properties of the rare gases of atmosphere which he thought to be devoid from certain disturbing factors have not been justified. Still, the author is not willing to abandon his endeavours to find the definite solution of the problem. Enunciating a rather daring hypothesis, he draws attention to the unceasing variations undergone by everything in Nature, being, so to say, in a state of continuous flow. The properties of radio-active gases, and more especially of the emanation given off from them, seemed to present a similar inconstancy. With the collaboration of Mr. Soddy, the author has recently succeeded in producing helium from radium, radium salts supplying gradually this element, which, seemingly, so far from being an impurity of radium compounds is continuously formed by the latter. The author thinks that the emanation, while undergoing a separation, gives rise to the formation of helium, and that the superior terms of the same group of elements are possibly polimeries of the lower term, the imperfect regularity of atomic weights being due to the negative electricity and the amounts of mass projected during this decomposition.

A Contribution to the History of the Electrolysis of Water.

In a paper read before the recent Congress of German Naturalists and Physicians, Dr. A. Neuburger gives an interesting contribution to the history of the electrolysis of water. Lavoisier's experiments, intended to elucidate the formation of water, on being continued by the two Dutch chemists, Deiman and Paets van Troostwyk, resulted in 1789 in the first electrolysis of water being obtained. Now these experiments were at the beginning wrongly interpreted, it being thought that the electrolysis of water would result in an alkali and an acid being produced. This explication, it seems, was due to the impurities contained by the water and to the alterations of the glass vessels used. Now whereas, according to the opinion universally adopted, the merit of having elucidated this error and shown the only products of the electrolysis of water to be pure oxygen and pure hydrogen is ascribed to Davy, whose papers on the question was published in 1806, Dr. Neuburger shows the priority of this to belong to P. L. Simon, then Professor at the Berlin Architectural Academy, whose experiments on the electrolysis of water were published as far back as 1801 in Gilbert's Annalen. As regards the question as to why Simon's work should have been forgotten, whereas Davy's merits are being praised in all the treatises on the subject, the author thinks this fact to be due to a more or less voluntary omission by Berzelius.

A New Method for Determining the Dielectric Strength of Highly Insulating Substances.

A new method for determining the dielectric strength of highly insulating substances is suggested by Dr. A. Walter (see Electrotechn, Zeitschr, No. 39, 1903); this process is based on a discovery made by the author some months ago in conjunction with Prof. Kiessling, viz., that even rather thick layers of highly insulating substances may easily be perforated by electric means, when pouring on one of the surfaces a drop of hot wax, stearine or the like, about 2 cm. in diameter and 2 mm. in height, and perforating the latter, after it has become quite cold, in its middle by means of a thin needle as far as the plate to be pierced. Now the author observed the fact that for a given plate of a similar substance there is always a certain minimum spark length for which the perforation is just possible, this minimum spark length being proportional to the thickness of the plate for the same substance. Dr. Walter therefore terms dielectric strength of an insulating material the minimum spark length in air, producing a perforation in less than a minute in layers of the material 1 cm. in thickness.

Electrification by Contact on the Theory of Colloidal Solutions.

The electrification by contact shown by bodies immersed in water plays a very important part in connection with many physico-chemical and biological phenomena. As pointed out in a paper by J. Perrin, recently read before the French Academy of Sciences, it is highly probable that colloidal solutions are formed of *granules* invisible under the microscope, though much greater than molecules, bearing electric charges; in fact, they are found to follow the lines of force on being placed in an electric field.

In order to account for the behaviour of such solutions, and more especially for the causes responsible for a stable equilibrium being produced for a certain diameter of the granule, the author suggests the following theory:

The surface tension and cohesion will favour the increase of a granule, whereas the electrification of the latter is a cause of disaggregation, these two opposite influences compensating one another for a certain diameter of the grains.

In the case of very small surfaces, the electric charges are no more comparable to homogeneous layers, but should be regarded as consisting of one or more distinct centres, each of which is equivalent to an electrode, a smaller quantity of electricity being irrealisable. Now let in a supersaturated solution with regard to a substance A be formed a germ of this substance. This germ being at the outset extremely small, will hardly ever bear any charge; as, however, it gradually increases, the germ will beyond a certain size bear as an average one electron, and as no cause will prevent it from further increasing, it will eventually bear two electrons exerting a repulsion on one another and expanding the granule formed. This repulsion may become sufficiently great to produce the *segmentation* of the granule, when either granule will grow in the same way as a primitive granule, to be segmented again, and so on. This phenomenon would explain the well-known behaviour of many live cells. It may generally be assumed that this separation will take place whenever the electric energy liberated by this segmentation is superior to that corresponding to the union of the two fragments on account of the cohesion, and especially of the surface tension. If the repulsion of the two electrons be insufficient to separate the granules, the segmentation of the latter may occur, as the granule having still become greater bears a greater number of electrons. Beyond a certain size, however, the electrons of opposite sign floating in the liquid cannot any more be neglected; the granule will become more and more comparable with a closed electric sheet, the electric action being incapable of overcoming the surface tension and cohesion. In fact, if a substance by the contact of water receives a small surface tension and a strong electrification, the stable equilibrium of the system will be realised by an emulsion of granules of definite diameter, disseminated in the water. If the contact electrification be increased, the mean thickness of the grain corresponding with a stable equilibrium will be diminished; if this electrification be diminished, the size of the grains is increased; if, finally, it be diminished below a certain critical value, any segmentation will become impossible.

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The Limits of Microscopic Vision.

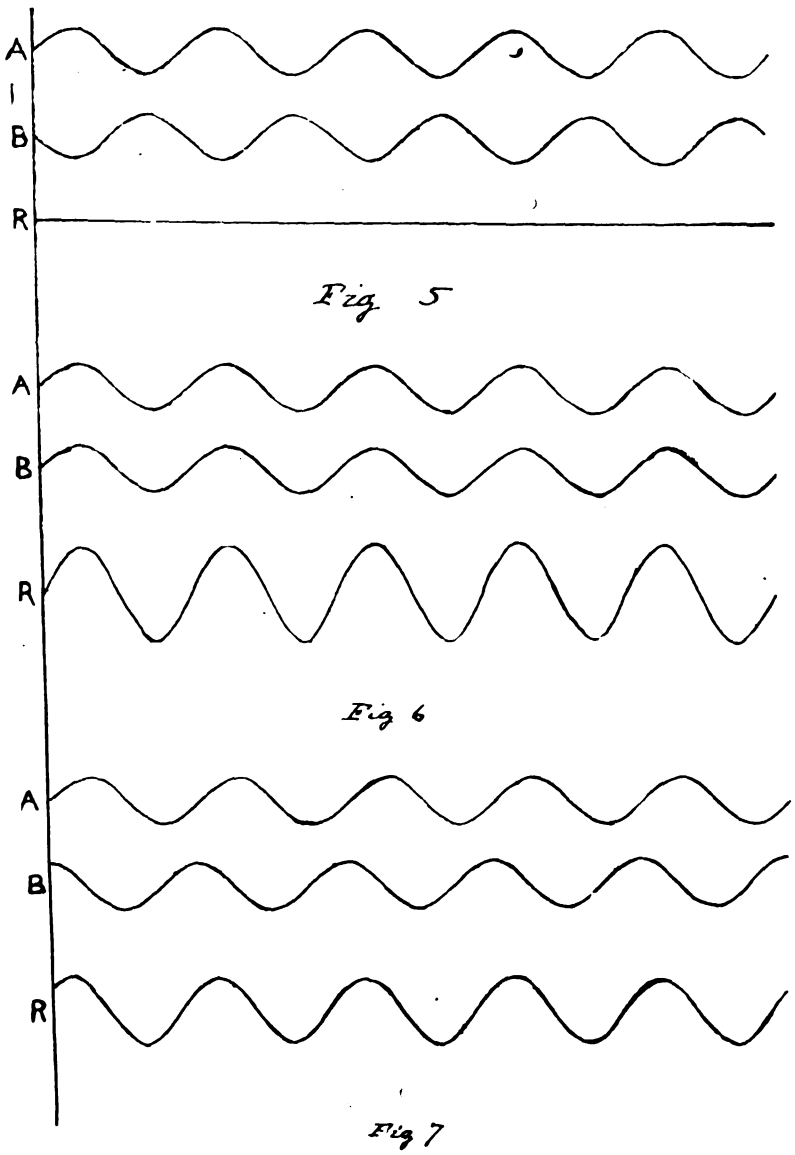
By G. H. BRYAN, Sc.D., F.R.S.

Part II.—Diffraction—Resolution of Regular Structures.

IN Fig. 5, A and B represent two sets of waves of equal amplitude and wave-length, so placed that the crests of one set correspond with the troughs of the other. If two such wave systems are superposed they will neutralise each other so that their resultant will be an absence of wave motion, represented by the straight line R.

In Fig. 6, we have two sets of equal waves, A and B, which have their crests and troughs coincident, and these, when combined together, give a resultant wave motion R of the same wave-length, but double the amplitude of either compound.

For intermediate positions of the wave systems A and B (Fig. 7), the resultant wave motion R is less than in Fig. 6, but it never vanishes except for the position shown in Fig. 5.



Finally, we have in Fig. 8 *three* sets of equal waves A, B, C, which, when superposed, neutralise each other. The crests of the waves in B are in front of those in A by a distance of one-third of a wave-length; similarly in C, the crests of the waves are a third of a wave-length in front of those in A.

[The meaning of amplitude and wave-length is shown by the measurements marked a and λ in Fig. 9, which shows two waves of equal amplitude, but the wave-length of the second is double that of the first.]

With these prefatory explanations we may proceed to explain the diffraction effects produced by a grating, under which term may be included any structure which repeats itself at regular equidistant intervals, such as the markings on most of the diatoms which are used as test objects.

We suppose for illustration, that the grating is formed by equidistant slits or openings A, B, C, D, in a screen, which is illuminated by plane waves falling on it from below. After passing through these openings the waves will spread out from them in all directions, and their aggregate effect in different directions will have to be considered.

(1) It is clear that the portions of the waves which travel straight on will give rise to a transmitted beam of light.

(2) In figure 10 the wave coming from B in the direction BL has exactly *one extra wave-length* to travel before it comes to L, opposite A. Similarly, the wave from C has an extra wave-length to travel before reaching M, opposite B, or two extra wave-lengths before coming opposite to A or L, and so on. The relative positions of the trains of waves are the same as in Fig. 6, the only difference being that the crest of the wave which has just left A is opposite to those of the *next preceding* wave which left B, the *preceding wave but one* which left C, and so on. The waves thus combine together to form what is

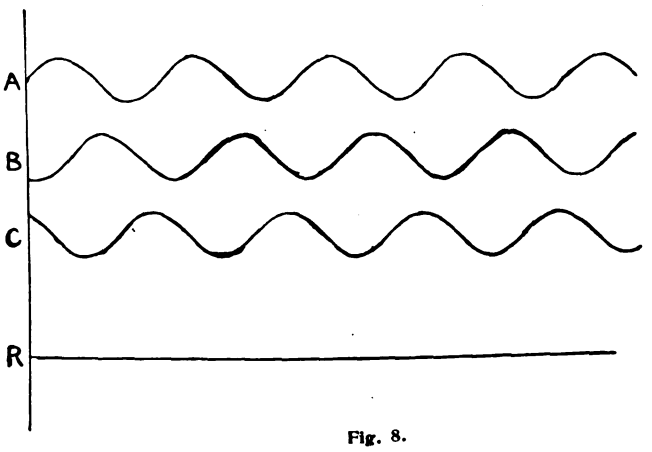


Fig. 8.

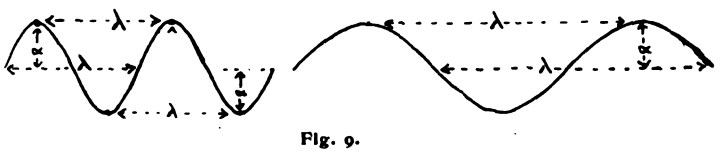


Fig. 9.

called a *first diffracted beam* of light. The direction of this beam is determined by the fact that the waves which go through one hole have to travel *exactly one wave-length further* before they come opposite the waves which go through the next preceding hole. This, we express by saying that the "difference of path" is exactly one wave-length. In the case where the incident light is perpendicular to the plate (Fig. 10), this means that BL, CM, DN are each equal to one wave-length. Another first diffracted beam will be sent out in the opposite direction indicated by DK.

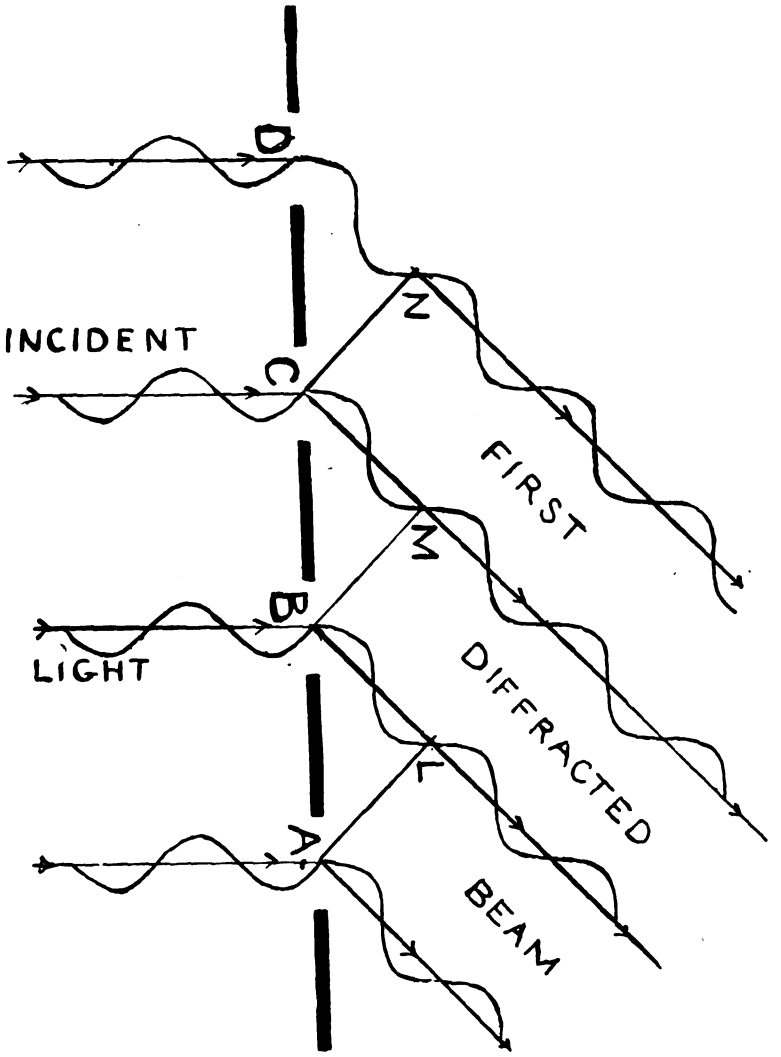


Fig. 10.

(3) Figure 11 shows the case where the light from B has to travel exactly *two extra wave-lengths* before coming up with the light from A, and so on. The waves in this case give rise to the so-called *second diffracted beam* of light, and we say that the "difference of path" is two wave-lengths.

(4) Similarly, a *third diffracted beam* would be produced in the

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direction in which the waves from one opening have to travel exactly *three extra wave-lengths* before coming opposite to those from the preceding opening, *i.e.*, with a difference of path of *three* wave-lengths, and so on.

(5) The number of diffracted beams is limited by the condition that the distance between the centres of the openings must be sufficiently great to allow of a difference of path of the corresponding number of wave-lengths, and Figs. 14, 15 show that as the distance between the centres is increased the diffracted beams approach the

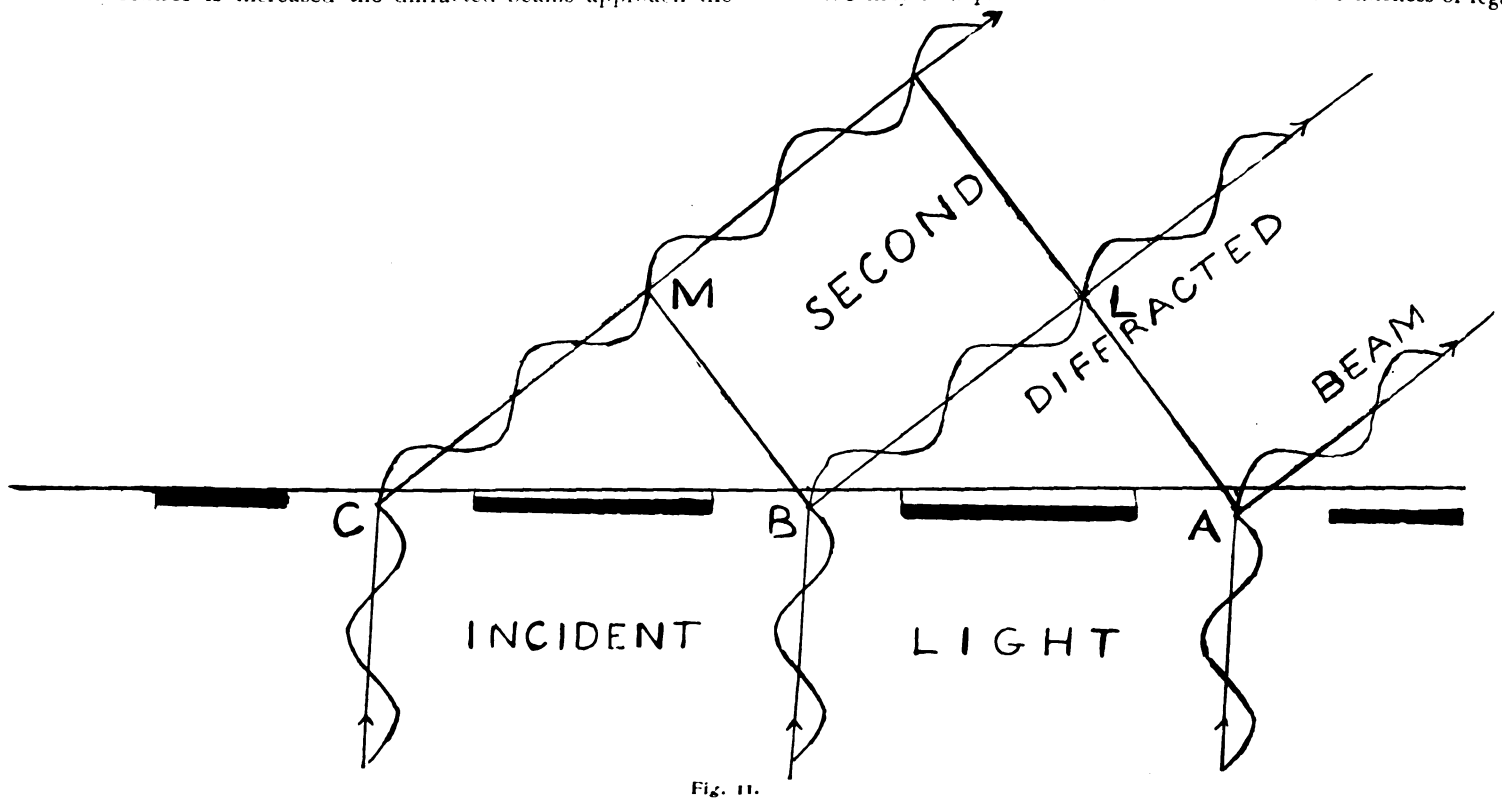

Fig. 11.

transmitted beam and conversely, so that the finer the grating the more obliquely are the diffracted beams sent out.

(6) In the case of a grating containing a considerable number of openings, *no light* is emitted in directions intermediate between those considered above. Thus (Fig. 12), in a direction corresponding to a "difference of path" of $\frac{1}{2}$ or $1\frac{1}{2}$ wave-lengths, the waves from A, B will be in the relative positions shown in Fig. 5, and will neutralise or interfere with each other. For a "difference of path" of

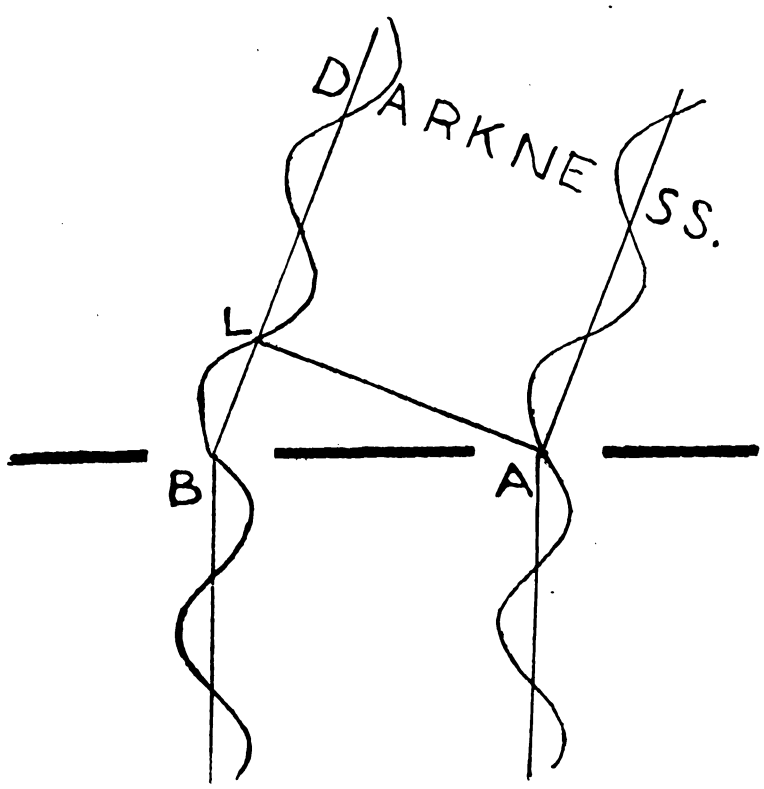

Fig. 12.

$\frac{1}{3}$ or $\frac{2}{3}$ a wave-length (Fig. 13), the waves from three successive openings A, B, C will interfere as in Fig. 8, and so forth.

A very good illustration of diffraction is afforded by a thickly-strewn slide of *Pleurosigma angulatum* or *P. quadratum*, in which each diatom acts as a separate grating. By placing it in the sunshine and gradually varying its inclination, the different colours of the spectrum, from violet to red, will be seen in turn, produced by the diffracted beams of the corresponding wave-lengths. As the wave-length of violet light is about half that of red light, the second diffraction beam for violet nearly coincides with the first diffraction beam for red. Hence, just after the red colour has disappeared the diatoms will be seen of a violet colour due to the *second diffraction beam*, and this phenomenon may be followed as far as the green.

Diffraction by gratings can be also illustrated by a piece of gauze held in front of a distant bright source of light. A better plan is to place a piece of muslin over the object-glass of a telescope, which is then pointed at a bright star; very pretty effects will be seen.

We may now proceed to estimate a limit to the fineness of regular structures, which are visible under the microscope, such as the markings on diatoms.

We assume that a distinct image can only be formed by the convergence to a focus of light emanating from the same source, but travelling towards the focus in different directions. In the case of a grating the only light available is the transmitted beam and the diffracted beams, and hence we can now understand (as far as is possible without going into mathematical details), the following statement:

In order that a series of markings arranged at equidistant intervals shall be visible under the microscope, it is necessary that, at least, the first diffracted beam should be received into the objective of the microscope in addition to the transmitted beam.

Now, the maximum "difference of path" which can be obtained with a given grating will be produced when the incident light just

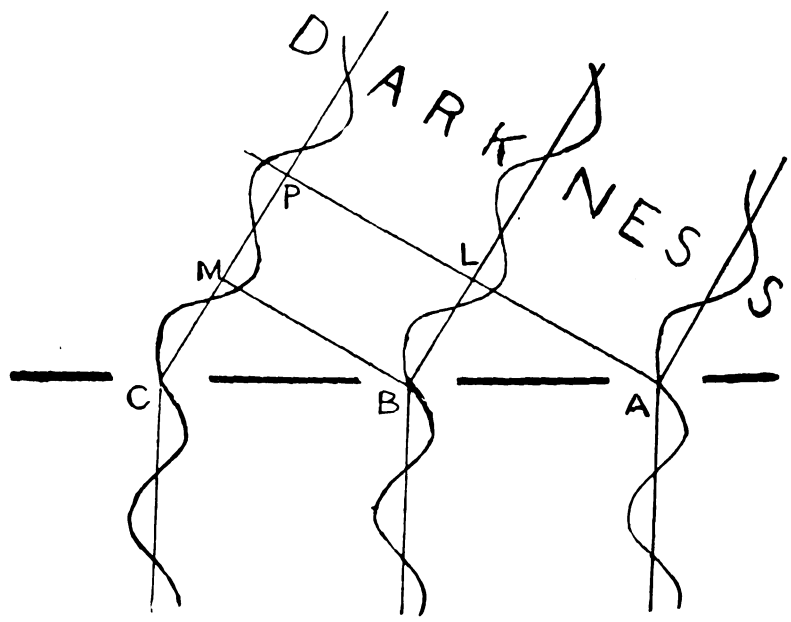

Fig. 13.

grazes the grating at a very small angle from below and the diffracted beam comes off at a very small angle above in the opposite direction. This can only be rendered possible by increasing the apertures of the objective and sub-stage condenser of the microscope to the extreme limits. The "difference of path" is, therefore, less than twice the distance between the markings on the grating, though it may be made to approach to this limit by increasing the obliquity of the light (Fig. 16).

We conclude *that in order that a regularly-marked structure may be*

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visible under the microscope, the distance between the markings must be greater than half a wave-length of light.

By reasoning well known to mathematicians [depending on the fact that the cosine of a small angle differs from unity by a small quantity of the second order], it follows that if the inclinations of the incident and diffracted beams are "*very small*," the "difference of path" PP + BQ in Fig. differs from 2AB by not a *very small*, but a *very very small* fraction of either, and thus it is possible to resolve objects the distance between whose markings approaches extremely closely to the limit of half a wave-length.

The important part played by diffracted light in the formation of images was well shown by Dr. Johnstone Storey in some beautiful experiments with Mr. Grayson's ruled bands of lines. When three

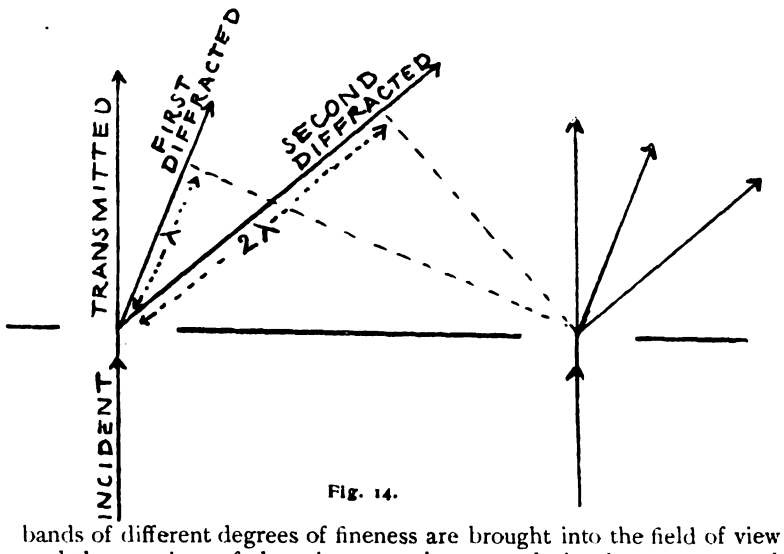


Fig. 14.

bands of different degrees of fineness are brought into the field of view and the eyepiece of the microscope is removed, the three corresponding diffraction spectra are seen one outside the other on both sides of the bright transmitted beam. By means of suitable stops Dr. Storey cuts off one or two of the diffraction spectra, and on replacing the eyepiece. the corresponding ruled lines have disappeared. In this way Dr. Storey can obliterate the middle ruling, leaving the coarsest and finest rulings visible, or can obliterate the extreme rulings, leaving only the middle one visible. Again, using a coarser set of rulings, in which the first and second diffraction bands both enter the objective, Dr. Storey obtains an interesting result by stopping off the first diffraction band. From what has been said above it is easily evident that the second diffraction band of a coarse ruling is coincident with the diffraction band of a ruling of lines twice as close together, and it is a remarkable fact that when the eyepiece is replaced, *double the actual number of lines are seen.* When both the first and second diffraction bands are transmitted, false images are still seen, giving the effect of faint lines midway between the actual rulings, and these only disappear

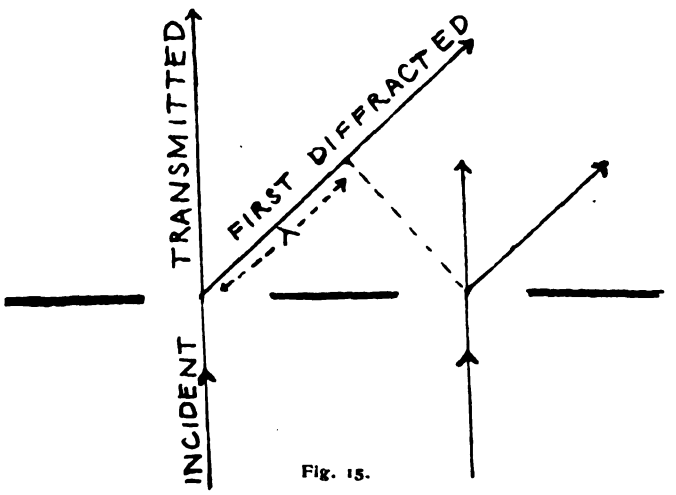


Fig. 15.

when the second diffraction bands are stopped off. It would be difficult to give a simple, concise, and at the same time rigorous explanation of this phenomenon, which is best explained by means of mathematical analysis, but it accounts for effects commonly observed under

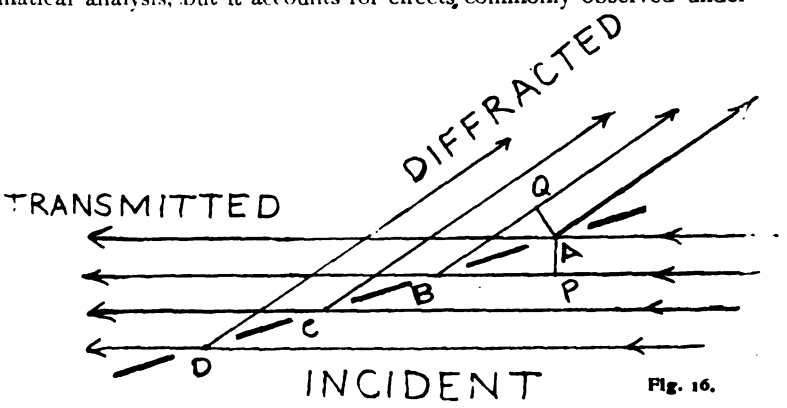
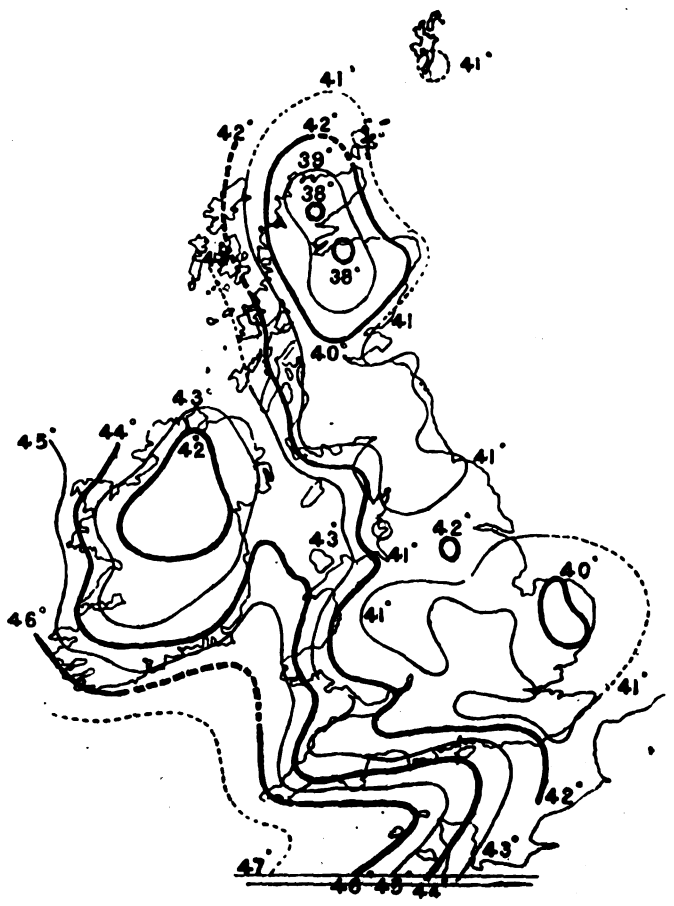


Fig. 16.

the microscope, such as the apparent striations observed some time ago between the lines of exclamation marks on the Padura scale or other insect scales, and a knowledge of the existence of such effects is of importance in interpreting structures seen under the microscope.

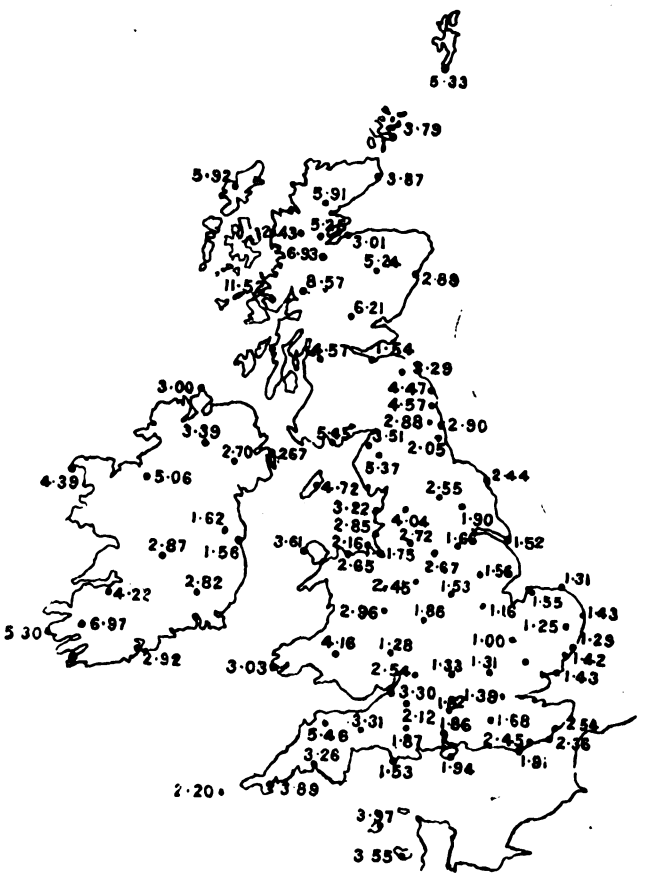
LAST YEAR'S WEATHER—DECEMBER, 1902.

DISTRIBUTION OF MEAN TEMPERATURE.



The general distribution was in close agreement with the normal.

RAINFALL.



Rainfall amounted to less than the average in nearly all parts of England and Ireland, but exceeded the normal at most of the Scotch stations, and also in the extreme north of England.

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A British Caterpillar Fungus.

By G. H. BRYAN, Sc.D., F.R.S.

THE New Zealand caterpillar fungus (*Cordiceps Robertii*) is comparatively well known in this country, thanks to the descriptions of it given in books of travel and popular works on Natural History. An excellent figure of it and the moth which it attacks is given in Pouchet's *Universe*. That similar vegetable parasites exist in the British Isles is, however, little known except to botanists.

In a green bank of moss under trees in the autumn, one or more spikes of a bright orange-scarlet colour may sometimes be seen to

British Caterpillar Fungus.

shoot out. On carefully removing the moss, these will be seen to emanate from either a dead chrysalis or the body of a dead caterpillar. In the latter case the insect remains are frequently in such a disintegrated state as to be somewhat difficult of recognition, as will be seen from the left hand of the accompanying sketches. The specimens from which these figures were drawn were found in a wood near Bangor one or two years ago, but this year I have found similar ones in two places in the neighbourhood, in each case proceeding from the bodies of caterpillars which they had destroyed.

CORRESPONDENCE.

The Pressure Exerted by Rays of Light.

SIR,—In an article under the above heading by me which appeared in the November issue of the ILLUSTRATED SCIENTIFIC NEWS I regret to say an arithmetical error was made in three instances in estimating the total radiation pressure. The radiation pressure per square centimetre due to bright sunlight is correctly stated as 0·00006 dynes or 60 microdynes per square centimetre. In transforming this value, however, into its equivalent in pounds and tons pressure per square mile, by a great oversight the velocity of light was not reduced as it should have been to feet per second. Hence in three cases the total pressure due to light is given 5000 times larger than it is in fact. The pressure in pounds per square mile at the earth's mean distance was stated to be 15,000 lbs., whereas the correct value is 3 lbs. This error vitiates two other statements. The total pressure on the earth due to sunlight is 70,000 tons, and not 350 million tons as stated, and that on a square mile at the sun's surface is 62 tons, and not one-third of a million. The other figures are, I believe, quite correct, at least as to the order of their value. I am indebted to a friend for calling my attention to an error which ought to have been detected by me in correcting the proofs, but which, unfortunately, escaped my notice.

I am, yours faithfully,
J. A. FLEMING.

Result of Prize Competition.

LEEDSER (25).—A parachute, 100 ft. by 60 ft., is composed of steel framing with aluminium plates, which latter are pivoted so as to close and form resistance while machine is descending, but open when it rises. Above the centre a shaft projects mounting right and left handed fans which raise the machine vertically. Screws fixed at the ends of the machine give horizontal motion.

FARRANIGHT (35).—Two wings made of small shutters, so that the pressure on downward stroke will be much greater than upward. Wings made after the style of a fan so that they may be shut up or extended. This done automatically by pendulum, so that on machine tilting the uppermost wing will be partly closed. *(Original, but it is doubtful if this tilting would in practice be sufficiently serious to warrant the complication.)*

KHARKI (35).—Wings composed of movable slats which are opened and closed by means of toothed-wheel gearing during the up and down strokes respectively. *(Gearing, as drawn, very unnecessarily complicated.)*

KITEX (25).—Kites support a car containing engines and screw propeller. Latter pulls against kites, causing them to ascend. To travel with the wind propeller slowed down.

LIGHTNING (20).—Large cylinder, with wings along sides, contains a continuous spiral fan driven by motor below. The after end of cylinder is constructed like a concertina, by contracting either side of which the machine can be steered.

R. M. (30).—Aëroplane with driving propeller in rear and vertical propeller to assist in lift. Driven by 3-h.p. petrol engine. Sliding weight to give upward or downward inclination.

BACILLIGRAPH (28).—Umbrella parachute, with small pair of wings in front and a large pair behind; latter curved downward. Aëronaut works cycle-pedal, or motor can be added. Machine preferably shot up from spring platform.

PRIFYSGOL (we hope the spelling is correct!) sends us a solution, but, as he owns, he transgresses most of the rules, sending no coupon, and the article is about long enough to fill a couple of our pages. Nevertheless, it is an important contribution, embodying many undoubted truisms. It will only be necessary here to quote the summary, which is that the solution "depends entirely on mathematical calculation of the criteria of longitudinal stability accompanied by experimental determinations of the constants occurring in the biquadratic equation on the roots of which this stability is shown to depend." No definite design is described, as this is considered to be premature without first mastering the theories.

CLYDE (75). Central body containing motor has reciprocating wing-frames mounted on each side. In each frame several propelling vanes are pivoted, which, by impact with the air, assume alternate oblique positions, and drive the whole along. The angle of inclination of the vanes can be varied by means of crank rods, so as to give a maximum of lift for starting. A front aëroplane and a steering tail are added. *(Liable to be heavy, as compared to more simple devices.)*

KASS No. 1 (70). A machine very similar to that of the Messrs. Wright (described some months back in *I.S.N.*). Operator, lying horizontally, works treddles with his foot, and drives screw propeller in rear of centre of machine. Rudder in front, "like a box without ends," can be moved to give any angle, vertical or horizontal. *(Doubtful if sufficient thrust can be thus obtained to propel machine fast enough to support weight.)*

KASS No. 2 (50). A number of wings move up and down (six on each side), closing on the upstroke and opening on the down. These lift and sustain the weight of the machine, while two screw propellers drive it horizontally.

BUZ (68). Rectangular body with pointed ends suspended between two wings shaped like box kites. Third "wing" stretched over the body. Two propellers revolved by means of belts from a petrol motor are placed on each side, inside the "wings." Horizontal steering effected by stopping either propeller. To incline body, petrol tanks moved forward. *(Not very original, and no method described of how to rise off ground.)*

K. O. H. Petrol motor in circular car drives an air propeller mounted on vertical shaft below the car. A smaller horizontal propeller can be connected when desired. *(What is to prevent whole machine spinning round in opposition to propeller? and what does it rest on when on the ground?)*

MEPHISTO No. 2 (65). Two large 4-bladed propellers or "revolving aëroplanes," acting vertically, support engines, &c. Two similar, but smaller, propellers, mounted as a "tail," balance machine, and effect desired inclination. Another propeller, on transverse horizontal shaft above centre of machine, maintains transverse stability. *(Not likely to attain great speed.)*

NEMO (55). Steam turbine, with oil fired water-tube boiler, rotates a propeller in front. On either side a pair of wings like a bird. Behind a vertical and horizontal tail. Balancing effected by altering the position of engine and seat for man, or automatically by weight, suspended by a rod, opening steam port. Started by running down an incline (mounted on wheels).

GUNNER (50). Fans with large blade surface arranged in line at right angles to direction of advance, acting so as to draw machine upwards. Forward motion obtained by screws behind. It is pointed out how, with aëroplanes, the increasing speed throws centre of pressure forward, and how difficult it is for this reason to maintain equilibrium. Therefore, instead of aëroplanes, large fans used. Machine must start from wheels or trolley. "No known power is sufficient to rise without forward motion." *(To this last sentence we offer objection. Several models have been made to rise vertically upwards.)*

MEPHISTO No. 1 (50). General principle, to act as in the flight of winged creatures, but with rotating instead of reciprocal wing surface. Two "rotating structures," each consisting of a wheel with six groups of Venetian blind-like blades around the circumference, are mounted one on either side of central body of machine, on horizontal fore-and-aft shafts. The angles presented by the blades are varied by the action of a cam and springs, and correspond to the action of a bird's plumes. Mechanism, controlled by gravitation, adjusts equilibrium. *(Rather intricate, and liable to be heavy.)*

The monthly prize has therefore been won by

"CLYDE,"
WILLIAM COCHRANE,
11, King Street, W.

to whom one guinea has been sent.

The Grand Prize of £100.

Twelve problems having now been set, and the solutions judged upon, we have pleasure in announcing that the greatest aggregate of marks obtained is that of

"KASS" with 874,

but, as long ago as the second competition, this competitor was awarded 50 marks, with, however, a rider to the effect that the solution was sent in too late, and that "should he, by including these marks, become entitled to a prize, an objection may be lodged and the case further considered." It is a curious fact that he has now obtained the greatest number of marks, if this 50 be included, but is not leading if these be deducted, since

"MEPHISTO" has 840.

The prize therefore lies between these two, with whom we are communicating, and no decision will be arrived at until we have their views. "Cantab" writes suggesting that, as the nature of the competition was entirely changed by the alteration of rules after the first six problems had been set, the twelve problems for the £100 prize should commence from the date of alteration, adding that he is sure the majority of competitors would wish this.

We believe so, and would very gladly comply with the suggestion, but we fear that the two competitors now at the head of the poll might not fall in with the idea.

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THE ILLUSTRATED

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COVERS, in blue cloth and gold lettering, for binding the year's volume or encasing copies, can now be obtained. Price 2/6, by post 2/9.

To Our Readers.

A New Departure.

IT is with great pleasure that we have to announce to our readers a new departure in connection with the contents of the ILLUSTRATED SCIENTIFIC NEWS, and in respect of the form in which it will appear in the future. During the fifteen months in which it has appeared, and in which its influence and its circulation have increased far beyond the hopes that its Directors entertained when it was first founded, many plans have been suggested and discussed for increasing its value and its attractiveness to the Scientific Public. Some of those plans have been put into effect, as in the instance of the increase of the size of the periodical by four pages; or as in the addition of photographs and suitable illustrations; or the multiplication and choice of subjects. But while it is proposed to retain these intrinsically valuable characteristics of the paper, we have, in pursuit of the aim of continually appealing to a wider and wider public, decided to make an addition of a kind which for the present will result in something approaching a transformation of the appearance of the ILLUSTRATED SCIENTIFIC NEWS. With the February number of the ILLUSTRATED SCIENTIFIC NEWS will be incorporated the contents of our contemporary KNOWLEDGE. The first result of the amalgamation will be the addition of four pages, and the combined ILLUSTRATED SCIENTIFIC NEWS and KNOWLEDGE will begin its career next month with twenty-four pages. In other respects we shall aim at an addition of the subjects which are characteristic features of KNOWLEDGE, such as Astronomy, Natural History, Microscopy, and Botany, to those sciences, and the treatment of them, which have won for the ILLUSTRATED SCIENTIFIC NEWS what we hope we may describe as its popularity and its commanding position. For title we think it best to give precedence to the older-established journal, and in future we shall be known as KNOWLEDGE AND THE SCIENTIFIC NEWS. This notice of our intentions may be fitly concluded with the expression of a hope that they may prove in every respect satisfactory and of utility to our many readers.

Books in the Running Brooks.

By THE REV. W. TUCKWELL.

"WATER is the best of things," was the opening verse of a great Greek Poet's Odes. Calverley, to be sure, was of opinion that had the bard lived into the days of Bass and Allsopp, he would have recanted that wild opinion and transferred his eulogy to beer; but the Doric lyre cannot now be unstrung, and Pindar's sober song, like the pipes on Keats' Grecian Urn, "must still play on not to the sensual ear." In the Mosaic legend, water is the eldest daughter of creation, chief factor in the genesis of order out of chaos. Cheerful Mr. Piscator, in his walk on that fine fresh May morning up Tottenham Hill, professed to his two companions that all bodies are made of water, and may be reduced back again to water only. Emerson tells us that "the river bank, the weed at the waterside, however neglected in the passing, have a grace in the past, and take their place in the pictures of memory." "Rivers and the inhabitants of the watery element," says a much older writer, "were made for wise men to contemplate, and for fools to pass by without consideration."

But the contemplations of the wise are shaped by daily bent and habit. To the artist brooks and rivers are an element of light, reflection, tone, in the composition of his sketches. To the engineer they mean mechanical or electric motor force; to the geographer they are a boundary, to the schoolboy a playground; the poet peoples them with Naiads and Undines; the moralist sees human life parabled in the mountain brook, its continuity in the never-failing flow, its mutability in the swift sequent change of torrent, ripple, pool, its goal in the infinite sea. All these look upon the water as appropriate for illustration or for use; the naturalist loves it for itself; poring, like Gray's youth, upon the brook that babbles by, he peers into its recesses, ponders the shapes, life histories, transformation of the organisms which people its depths, makes comradeship with the animals that haunt its banks, the plants that decorate or fringe its floor—in a truer sense than mechanician, artist, poet, moralist, he finds Books in the running Brooks.

Mark Pattison used to pronounce him a scholar who should know his way among books as a stable boy knows his way among horses. So is the naturalist at home in Nature's libraries, finding his bookstore in quarry, moorland, brookside. Its shelves are closely packed, as in a collection where lack of space demands a double row of volumes. "Went home," says Macaulay, in his diary, "and counted my books; those in front are in round numbers 6000; there are many hundreds behind." Thus some of Nature's books are prominent and visible, others retired and recondite. Behind and out of sight are her animals, in front her flowers. Let us begin with these, taking them one by one as we should take down books, fingering them affectionately, and enjoying the thrill of knowledge and memory and association which each in turn sends rippling through the brain. Our path shall lie beside a quiet Midland stream of low clay banks, more abounding in life than the dashing brooks of Devonshire or the Lakes. On its willow-tangled margin pushes up in January the first scrolled and pointed arum leaf, to be followed soon by crimson female catkins in the overhanging hazel bushes. After these come in February the rathe primrose, strawberry, mercury, and chickweed, in March the masses of golden Lesser Celandine bid us listen for the little chiffchaff, our first returning migrant. Far richer and more varied is the summer and autumn decoration; heat will have faded the flowers in the open, but the cool stream on which the day star sparely looks preserves them fresh beside it. There the blue dewberry harmonises with dense yellow fleabane; purple bittersweet

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twines among the stunted sallows; a fringe of potentilla, water bedstraw, and herb twopence trails down from the grass above, edged where they meet the water by the graceful curling leaves of comfrey. Up from the river bottom rises the fragrant sweet-rush, into which, as we remember, Wonderland Alice steered her boat; all round it are the clustering turquoise masses of forget-me-not, the yellow iris, water plantain, flowering rush; at intervals the magnificent water-dock, tropical in banana foliage and ruddy spikes of fruit. On the still surface of the water swim the so-called water violet, pale blue spikes above and deeply cut submerged leaves below; the frogbit and water soldier, diving each winter to the bottom and rising again with the lengthening days of June; the exquisite fringed bog-bean amid lilies white and yellow, the duckweed entangled in green patches of conferva, precious to the microscopist for the brood of lovely animalcules which they imprison. All these front us first of all, visible as trees walking to the unobservant passer by, accessible in all their wealth of suggestiveness and plant lore only to the heart that watches and receives, without which, in the teaching of our great Nature-poet, both science and art are barren.

In a graceful poem of the Christian Year the stationary charm of flowers is contrasted with the fugitive timidity of bird and beast. The lilies of the field abide our gaze; on its animals the fear and dread of man have fallen; to consider them in their haunts we must be not watchful and instructed only, but motionless and silent. Walk openly by our brookside, and the splash of a plunging water rat, the swirl of a shooting pike, the twitter of an alarmed but invisible willow wren will be the nearest approach that you can effect; sit down amid the bushes or beside the alder trunk, make no movement and no noise; above all, speak no word—for to feral animals the human voice is ever the most alarming of sounds—and one after another will come forth to exhibit for your enjoyment. You will watch the gentle, graceful vole, not to be confounded with the obscene cannibal rat, seated on a willow stump to wash its round whiskered face, or masticate a stalk of arrowhead. You will see a brood of tiny water-shrews at play, chasing one another on the bank with squeals of frolic or of pretended anger, then, at a signal from the mother, scuttling all together into the stream to swim by alternate strokes of their curiously-fringed hind feet. The willow warbler will practise for you its descending scale of notes, the sedge warbler its loud persistent chatter, the reed-warbler its quiet crooning soliloquy. You will survey the kingfisher perched on a projecting bough, preening and oiling its brilliant feathers, anon dropping into the water like a stone to emerge with dace or gudgeon held crosswise in its long bill; and your scholarly mind will revert to Aristotle's description of the "blue green" bird, and to the alcyons loved by Thetis in the Georgics. These pageantries unfold to us as we sit, while below us is the swarm of whirligig beetles waltzing on the water surface, the long-legged Pond-skaters by undiscernible effort shooting to and fro, the rhythmic rise and fall of May flies. But as we gaze upon the smooth dark flow, our mind goes into the depths which it conceals; we long, like Asmodée in Le Sage's novel, to take off its roof and pry into its contents. That is easily done. We lie down with head above the water; ere long the eye will suit itself to the new medium and reveal all that goes on below. Crawling on the bottom we shall see the Caddis-worms, sheathed in leaves, sticks, straws, cemented grains of sand or shells of snails, drawing back hastily into their cylinders on the approach of their enemy the predaceous water scorpion. Floating in mid-water are the transparent phantom larvæ; below them the great water beetles, clinging to the stones with their suckered forefeet, then rising to imprison a supply of air between their wings and backs. We may have the luck to see the stickleback half projecting from the nest in which she broods over her spawn, while her mate, bold and gorgeous, in a suit of spiked and flashing mail, protects her incubating retirement. The amphibious water spiders creep down a rush stem from the upper air into the depths, "bathing unwet their oily forms," as Erasmus Darwin phrases it. Their bodies are shielded by a mackintosh of varnished web; they devour the prey they have captured up above; then take shelter in the dry thimble-shaped aerial nest, from which by successive air-bubbles they have expelled the water, until, dry as Gideon's fleece, it shines like a globe of quicksilver amidst the pool. Everywhere is the gnat larva, hanging downwards in the water, its air tube flush with the surface, its head free to feed below, changing by-and-bye into the strange helmeted pupa, floating finally on its boat of outworn skin, till, freed from the vile husk, it ascends to fly and sting and wind close to our ears its murmuring small trumpet. Most weird of all perhaps is the ugly dragon fly grub; its face covered with an uncouth mask like Bottom's ass's head. It creeps sluggish and repulsive but with cat-like purpose towards its prey, when the mask unfolds into a pair of sharp-toothed plates, which seize the victim and convey it to the horny jaws. Of the beautiful process which in due time transforms the unhandsome grub into the queenly dragon fly I need not speak; it is written in Tennyson's "Two Voices," and in Kingsley's "Water Babies."

All these are visible to our naked eye—the orb whose unwary mention by Martin Chuzzlewit so alarmed the mother of the modern Gracchi—but the naturalist has another eye in store, the microscopic eye denied to mortals in Pope's well-known lines. A small can of water, dipped from side and surface of the stream in its quieter parts, reveals fresh wonders to a three-guinea microscope: The Amœba, grandfather of animals, multiplying its race by division and subdivision of its protoplasmic body; the rhizopod protruding and withdrawing sunlike rays; the strange water-bears clambering with their six hooked claws; the Vorticella colony of tiny cups fringed with waving hairs, set on long stalks which spirally contract and elongate; the Volvox, a green globe revolving on its axis while it swims; the Melicerta, constructing mason-like its dwelling with bricks which it moulds and adjusts before our eyes; the diatoms, locomotive vegetables, engraved and engine turned as no machine on earth could sculpture them; the dancing water fleas through whose diaphanous shell we can discern the bi-lobed brain, its nerve-lines passing to the large compound eye, the masticating jaws and curved intestine, the pulsating heart, the ova in the parent body themselves transparent and revealing the live young within—with one or more of these I have often drawn round me an eager crowd of observers throughout a long evening's exhibition in some large town hall, the naked mystery of life, minute and novel, outweighing far in charm the most expensive makers' slides exposed in neighbouring instruments. And to the oft-repeated question of the eager artisan, "How can I get a microscope?" my answer, "Go for a twelvemonth without beer," has not infrequentiy borne fruit.

Magnified or life-sized, these are but a few random pages culled from the volume of our running brook; more no doubt than the banished Duke imagined in his forest exile, not more than any man or woman may train themselves to buy and to enjoy without money and without price. I am concerned to vindicate the profession and to justify the raptures of the naturalist, since the rage for specialisation, the *micromania* of our scientists to-day, what Ruskin called the dispassionate examination as distinct from the passionate love of Nature, has cast discredit on the large observer of life habits and surroundings in her realm. I have known illustrious botanical morphologists who could not systematise or identify a rare plant encountered in the fields; have walked with men adepts in the colouring of caterpillars, yet not knowing the difference between a locust and a grasshopper, a hive bee and an Eristalis, a male and female glow-worm. The Egyptian Typhon and his rabble rout hewed Osiris into countless pieces, and his devotees ever since go searching sea and land to find them. Some day they will all be gathered up, and the fair god resume his ancient form. So I suppose in time to come specialisation will have done its work, minutiæ be all worked out, and we shall revert once more to the picturesque and fruitful Nature cult of a Swammerdam, a Reaumur, and a Buffon. Meanwhile, lay to heart that the brookside is but a single cell in the Bodleian which Nature sets wide open to her votaries; that in hilltop, hedgerow, woodland, stone quarry, fresh galleries open ever out lined with unfolding stores, inexhaustible to the widening knowledge and the untiring labour of the longest life.

Who, then, so happy as the naturalist? Happy is the collector, be it of books, of pictures, or of china; but evils days may come upon him; his majolica and dragon ware, his proofs and etchings, his incunabula and Horæ, his "warranted early editions,"

> In their creamiest Oxford vellum,
> In their redolent crushed Levant,
> With their delicate watered linings,
> Jewels of price, I grant,—

may be torn from him by *sæva Necessitas*, and the charm and purpose of his life be lost. But the naturalist is self-sufficing; his treasures are green field and mountain side and river bank; while they are open to him he is independent, and his joy no man taketh from him.

Between the lower creation and ourselves—between the Almighty and ourselves—there hangs on either side of us a veil; the naturalist pierces both: the one by fraternal sense of kinship, the other by that cleared conception of the Maker which is born through intimacy with His handiwork. Hence the naturalist is almost of necessity religious; his moral tenderness grows with his intellectual acquirement, unconscious devotion haloes every fresh discovery and every new experience. Needless to insist that as a part of this the naturalist is of necessity merciful: the ghastly manglings of the laboratory, the savage barbarities of sport, become hideous and impossible to the man who has come to see in bird and beast and creeping thing people of his Father's pasture and sheep of his Father's hand.

> The Being that is in the clouds and air,
> That is in the green leaves among the groves,
> Maintains a deep and reverential care
> For the unoffending creatures whom He loves.
> One lesson, shepherd, let us two divide,
> Taught both by what He shows, and what conceals,
> Never to blend our pleasure or our pride,
> With sorrow of the meanest thing that feels.

The Mad Stone.

THERE is a widespread superstition in the Southern States of America, says Dr. H. C. White, that a wound caused by a sting of a venomous snake, or the bite of a mad dog, may be detected, and the poison extracted by the application of the so-called "mad-stone." The "mad-stone," which is of very rare occurrence, is a concretionary calculus found in the gullet of the male deer. As extracted it resembles a water-worn pebble, oblong in form, varying in size, but not greater, perhaps, than three inches in length by 1½ inch in thickness. The mad-stone superstition was current in New England at least as early as Puritan times.

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The New Edison Automobile Storage Cell.

By Dr. J. A. FLEMING, F.R.S.

THE limitations and possibilities of the modern types of secondary cell in which lead and lead oxides are employed in conjunction with dilute sulphuric acid are well known. Starting from the early investigations of Planté in 1859 and those of Faure in 1881, the present-day types of practical secondary cell or storage battery have been made up until recently almost exclusively of the lead oxide variety, and have been differentiated broadly into the Planté type and the packed grid type. Planté first showed that two clean lead plates placed in dilute sulphuric acid could store up a certain quantity of electrical energy if acted upon by a continuous electromotive force for a certain time. He also devised the process of "formation," consisting in giving charges in opposite directions, alternating with discharges and intervals of rest between, and showed that these operations resulted in the production of closely adherent films of lead peroxide and spongy lead on the two plates respectively, which made them electro-chemically different and able therefore to act as the elements of a voltaic couple when placed in dilute sulphuric acid. Faure's improvement consisted in applying oxides of lead to the plates instead of forming it out of them, and almost all subsequent invention was directed to holding this active material firmly in contact with the lead plates. In spite, however, of the immense ingenuity which the development of the lead secondary cell has called forth, it remains subject to certain inherent defects. The first of these is that the electronegative element or positive plate is essentially subject to local action, and this can only be prevented by giving the plate a form in which it is mechanically very friable.

The positive plate in general consists of pellets of peroxide of lead held in apertures of a lead gird, or in a dense adherent film of lead peroxide held on a lead plate of some kind. Whatever may be its form, the materials of which it is composed, viz., lead and peroxide of lead are electro-chemically different, and when immersed in contact in dilute sulphuric acid local voltaic action results, and the bare exposed lead is soon attacked and electro-chemically converted into sulphate of lead and peroxide of lead. No attempts to dispense with the lead backing have been very successful. Moreover the positive plates are also subject to distortions which result in detaching peroxide from the plate and the formation of "mud" on the bottom of the cell. The second great defect is the relatively slow speed at which the lead oxide plates can be efficiently charged.

The chemical actions in the cell are now known to consist, broadly speaking, in the formation of lead sulphate on both plates during the discharge of the cell and the breaking up of this sulphate into peroxide of lead on one plate and spongy lead on the other during the charge. But this sulphate of lead is not a very good electrical conductor and is not very porous, and if the operation of charging the plates is conducted too quickly the chemical action is chiefly confined to the surface layers and the result is that the deeper portions of the plate are not brought into action at all. From this result there is a diminution in the "capacity" of the cell as compared with that of a lower rate of charge.

Broadly speaking, it has been the general experience that where weight is no object, and where the lead cell can receive extremely regular use, its performance as a means of storing electric energy has been found satisfactory; but on the other hand where weight is an object and also the power to charge and discharge at high rates the "life" of the lead cell has left much to be desired. The experience gained in connection with the use of lead storage cells for electric traction has been valuable but costly, and it has induced some of the greatest inventors to turn their attention to the problem. Of late years, Mr. Edison has taken up the subject with all his characteristic inventive power, and making, as he always does, some radical departure from existing practice, has given to the world a storage cell of a new type which has excited the highest interest in the minds of all who have been able to examine it, and test it. In the construction of this storage cell Mr. Edison abandons entirely the heavy metal lead and the lead oxides as active materials, and also the corrosive dilute sulphuric acid used therewith as the electrolyte and takes for his elements particular oxides of iron and nickel, and for the conducting fluid a 20 per cent. solution of caustic potash.

The Edison automobile storage cell, as at present constructed, consists of a rectangular box of thin corrugated nickel-plated steel. This box is rectangular in shape and 13 ins. high, 5·1 ins. wide, and 3·5 ins. broad (see Fig. 1). Hence its cubic space is 234 cubic inches. The lid is soldered on with a special solder and rods connected to the two sets of plates come liquid-tight through the lid being insulated by ebonite bushes. There is also an aperture closed by a hinged stopper for adding liquid to the cell and an ingenious vent and valve covered with metallic gauze to allow gas to escape but not liquid. The external appearance of this valve arrangement is shown in Fig. 2 and it is extremely well designed and substantial. In this box are contained the plates in the cell at present described; there are 14 positive and 14 negative plates, but in a more recent type of cell this number is increased.

Each of these plates is a thin sheet of nickel-steel perforated with 18 rectangular apertures like windows. In these windows are fixed very shallow boxes or pockets of perforated nickel-steel, which are fixed in the apertures in the plate like the glass panes in the frame of a window. In one set of plates these pockets are filled with green nickel oxide NiO_2 and in the other set with ferrous oxide FeO. These oxides are mixed with graphite to render the mass porous and conductive. The nickel oxide and iron oxide plates are interleaved and separated by ebonite rods, the whole mass of 28 plates being exceedingly compact and close. The liquid in the cell is a 20 per cent. solution of caustic potash. The whole cell when complete weighs just under 18 lbs. The cell is charged in the usual way by a dynamo, and when fully charged its electromotive force is between 1·3 and 1·4 volts.

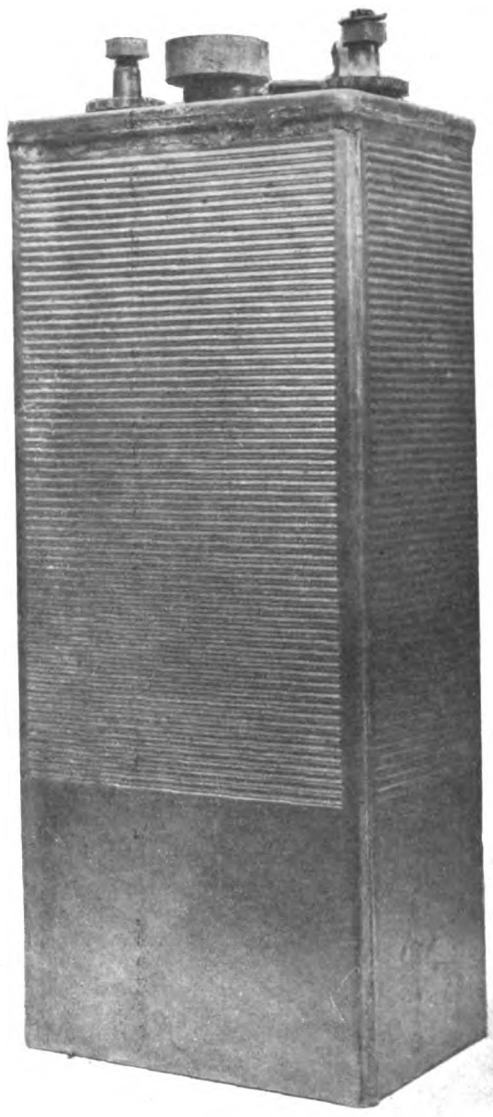

Fig. 1.—The Edison Automobile Storage Cell.

The chemical action during the charge appears to consist in the reduction of the ferrous oxide to the condition of spongy iron and the peroxidation of the nickel if already reduced. In the process of discharge the spongy iron is oxidised and the nickelic oxide NiO_2 reduced to nickellous oxide NiO. The caustic potash solution merely acts as a conducting electrolyte, and transfers oxygen from one plate to the other. Hence its density does not alter during charge and discharge, and there is no need to do anything to the liquid except to add a little distilled water occasionally to make up for evaporation. The cell has an extraordinary power of taking up electric energy. The above-described cell is nominally a 30 to 50 ampère cell, but there is no obstacle to charging it with 100 or 200 ampères in a proportionately shorter time. In the same manner the cell has an astonishing power of giving out electric current after charge. The writer has taken from the above-described cell currents varying from 380 ampères to 180 ampères without inflicting any permanent damage to the cell. The electrical capacity of the cell in question is, according to the tests made by the writer, about 170 ampère-hours, when the discharge current is 30 ampères, and the corresponding energy capacity is 210 watt-hours under the same circumstances. This corresponds to 11 or 12 watt-hours per pound of completely charged cell, and is an exceedingly good value.

The cell, however, when discharged at 93·5 ampères was found to have an ampère-hour capacity of 153·7 and a Watt-hour capacity of 178·4, these values being respectively 90 per cent. and 85 per cent. of the values for a 30-ampère discharge. Hence the cell shows itself to be capable of giving current discharges of very high value for its size and weight, and the power to be fully charged and fully discharged at a one-hour rate with exceedingly good efficiencies. The questions that then arise are whether the above-named powers are purchased at the expense of life. In a recent paper read before the

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Institution of Electrical Engineers, Mr. W. Hibbert has described his experiments with a 38-cell battery mounted on an automobile, and the tests to which he subjected the cell by prolonged practical trials when driving an electric car in all weathers and on all sorts of roads, are strong confirmation of the claims which have been made for the cell. Practical experience has shown that with lead cells when used for motor-car driving, the positive plates require renewal after running the cars about 1500 miles, and the whole battery when about 3000 miles have been run off. Long before these renewals, however, the cells require washing out to remove lead oxide mud, and the constant "topping up" with acid and the loss of charge on standing necessitates much skilled labour in the case of the lead cell. Mr. Edison, however, is now confident that with his present improved battery these difficulties will be largely, if not entirely, overcome.

It is obvious that the electric motor car driven by storage cells is the ideal vehicle for town traffic. Its noiselessness, cleanliness, absence of smell, and simplicity, render it the beau ideal of a carriage for city use. But if such a carriage is to come into extensive use, it must be capable of being fully charged in an hour, or at most in two

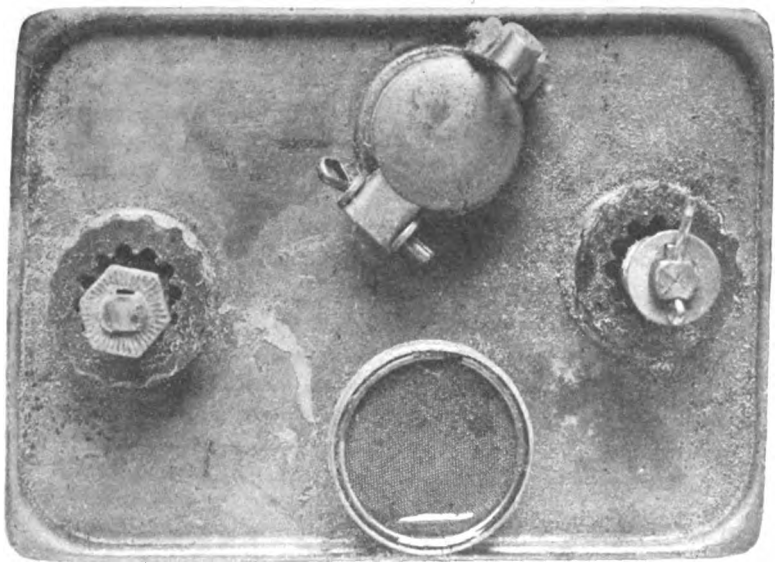

Fig. 2.—View of the Top of the Edison Cell showing Valve and Terminals.

hours. If put on the circuits at 7 a.m., it must be ready to take its owner out at 9 a.m. or 10 a.m., and be charged for the day's work. To do this, however, the first essential is that the battery shall be able to take up charge and give out current, far in excess of its normal working current without damage. Although great improvements have been made of late years in lead cells, the maintenance expenses when used for traction work have been hitherto found to be very heavy.

There seems good evidence, however, that Mr. Edison has made an important advance in storage battery construction, and that his nickel-iron cell is destined to be a valuable addition to the resources of the electrical engineer. It seems perfectly clear from the experiments already made with it that the local action in the cell is exceedingly small if any, and that the construction of the cell will not easily permit loss of capacity to occur through the mechanical removal of the active material from the plates by shocks or vibrations. Taking the cell even as we find it at present, we can by its aid store up in 124 of these cells, occupying a space of 17 cubic feet, energy equal to 35 horse-power hours. Hence 20 tons of these cells, occupying a space of 340 cubic feet, would be capable of giving out nearly 700 horse-power during the hour, and would suffice in conjunction with suitable motors to drive an ordinary express train from London to Brighton under one hour. In considering the useful electrical capacity and discharge, we cannot, however, neglect the questions of relative cost, and of the life of the cell; but exact data on these points are not yet fully at disposal. In the invention of this battery, Mr. Edison has proceeded on scientific and practical lines. There are only seven ordinary metals of which the oxides are not soluble in a 20 per cent. solution of caustic potash, and of these only two, namely, the oxides of iron and nickel are sufficiently abundant or cheap to form the ingredients of a commercial secondary cell. The advantages gained by the use of an alkaline solution in place of the usual dilute sulphuric acid are very great. Iron and nickel and nickel-plated steel are quite unacted upon by solutions of caustic potash. In fact, polished iron will keep bright for years if immersed in dilute potash. Hence, a great advantage is secured in the use of this latter as an electrolyte since thin steel containing vessels can be used instead of the ebonite or celluloid-lined teak boxes or glass cells necessary when dilute sulphuric acid is used. Also the corrosion of terminals or alternative necessity for "burning" together the lugs of lead plate are removed. Whilst experience shows that no new invention is free from its own characteristic defects, it appears clear, however, that the Edison nickel-iron cell has a marked superiority in some respects over existing forms of secondary cell. The low voltage relatively to the lead cell has been asserted to be a disadvantage, but for traction purposes this, however, is not any real drawback, as the motor can always be adapted to any voltage. The real basis of comparison between various forms of cell is not easy to define. We have the various factors of life, bulk, cost, ampère-hour capacity, watt-hour capacity; each of the last two reckoned in terms of battery bulk or battery weight, also maximum charge and discharge currents per square foot of plate surface. These factors have different relative importance in the various uses to which the secondary cell can be applied. In this matter, therefore, as in the comparisons of engines, dynamos and lamps, it is impossible to apply the word "best" in any general sense. One type of cell will continue to be best for one purpose, and another for another purpose, but none of them will combine every possible advantage with entire absence of every possible drawback.

Nevertheless, it appears unquestionable that Mr. Edison has laid electrical engineering under a fresh obligation, by bringing his great inventive powers and experience to bear upon the improvement of the secondary cell. He has made a step forward in a direction altogether different from that of current invention in connection with storage battery improvement, and has taken a new departure in this branch of practical science, which is destined to be of great utility in connection with the storage of energy for commercial purposes.

Astronomical Notes for January.

THE SUN.

ON the 1st the sun rises at 8 h. 8 m. a.m., and sets at 3 h. 58 m. p.m. On the 16th he will rise at 8 h. 2 m. a.m., and set at 4 h. 18 m. p.m. On the first-named date the length of the day will be 7 hours 50 minutes, that of the last-named being 8 hours 16 minutes.

Daybreak occurs on the 1st at 6 h. 2 m. a.m., and twilight ends at 6 h. 4 m. p.m., the times on the 16th being 5 h. 59 m. a.m. and 6 h. 21 m. p.m. respectively. The sun's apparent declination at noon on the 1st will be 23° 5′ 48″ S., with an hourly variation of 11″·11, his right ascension on the same day being 18 h. 42 m. 4 s., with hourly variations amounting to 11·05 secs.

The earth will be at *least* distance from the sun on the 3rd.

Sunspots continue to increase in a manner which gives promise of a fairly active year for observers of these phenomena.

THE MOON.

The moon will be full on the 3rd at 5 h. 47 m. a.m., attain her last quarter on the 9th at 9 h. 10 m. p.m., become new on the 17th at 3 h 47 m. p.m., and reach her first quarter on the 25th at 8 h. 41 m. p.m. She will be in perigee on the 4th, and in apogee on the 19th.

When full the moon will rise at 4 h. 59 m. p.m., at last quarter she will rise at 0 h. 40 m. a.m., and at the period of first quarter she will set at 1 h. 1 m. a.m.

Occultations will occur (1) on the 1st, when 111 Tauri (mag. 5·2) will disappear at 6 h. 9 m. p.m., at 170° from the *vertex*, and reappear at 6 h. 49 m. p.m., at 250° from V; (2) on the 2nd when 130 Tauri (mag. 5·5) will be occulted at 5 h. 0 m. a.m. at 43° from V., reappearing 50 minutes later at 246° from the point named; (3) on the 3rd when 26 Geminorum (mag. 5·1) will be hidden at 1 h. 34 m. a.m., at 40° from V.; and emerge 58 minutes subsequently at 274° from that point; (4) on the 5th, when o Leonis (mag. 3·8) will disappear at 10 h. 13 m. p.m., at 167° from V., and reappear at 11 h. 9 m. p.m. at 295° from V.; and (5) on the 31st when λ Geminorum (mag. 3·6) will disappear at 3 h. 6 m. a.m., at 66° from V., reappearing 57 minutes thereafter at 234° from the spot mentioned.

It may here be mentioned that there will be *no eclipse of the moon* during 1904.

THE PLANETS.

Mercury will be in *inferior conjunction* with the Sun on the 17th, and though technically an "evening star" at the beginning of the month, is practically invisible throughout,

Venus is still a "morning star," rising on the 1st at 4 h. 21 m. a.m., with R.A. 15 h. 36 m. 15 s. and S.D. 16° 39′ 50″. At the end of the month she will rise at about 5 h. 30 m. a.m., and her southern declination will then have increased to 21° 57′ 50″. Her brilliancy is now rapidly fading.

Mars may be treated as invisible for our present purposes.

Jupiter is still an "evening star." On the 1st he sets at 10 h. 12 m. p.m., with R.A. 23 h. 17 m. 10 s., and S.D. 5° 55′ 43″. He is now rapidly nearing the sun, and by the 29th he will set as early as 8 h. 51 m. p.m.

Saturn is now almost entirely swallowed up in the rays of the sun, and is therefore virtually invisible.

Uranus is practically invisible throughout the month.

Neptune is still favourably situated for the observer, rising on the 11th at 2 h. 49 m. p.m., and not setting till 7 h. 11 m. a.m. next day is therefore above the horizon throughout nearly the whole of the hours of darkness. His R.A. on the date mentioned will be 6 h. 17 m. 51 s., and N.D. 22° 18′ 9″, or, in other words, in close proximity to the star μ Geminorum.

THE CONSTELLATIONS.

At 10 h. p.m. about the middle of the month Orion is on the meridian. This fine constellation, together with Canis Major, Canis Minor, and Taurus, make a very brilliant display indeed in our southern skies, the groups of stars named containing so many gems of the first magnitude: *e.g.*, Sirius (*α* Canis Majoris), blue; Procyon (*α* Canis Minoris), white; Betelgeuse (*α* Orionis), red; Rigel (*β* Orionis), white; and Aldebaran (*α* Tauri), red.

Minima of the variable star *Algol* (*β* Persei) occur at times suitable for the ordinary observer as follow: On the 12th at 9 h. 10 m. p.m., and on the 15th at 5 h. 59 m. p.m. This star is best observed in the winter months, and may in January be found at a somewhat great elevation to the westward. It may, perhaps, be as well to mention here that the variations in the brightness of this star are easily observed, that its period is 2 days 20 hours 49 minutes, during which time it decreases steadily in brightness. Its *normal* brilliancy of about 2½ magnitudes endures for about 2 days 15 hours. Its *minimum* (about 4 magnitudes) lasts about half an hour.

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An Australian Lake.

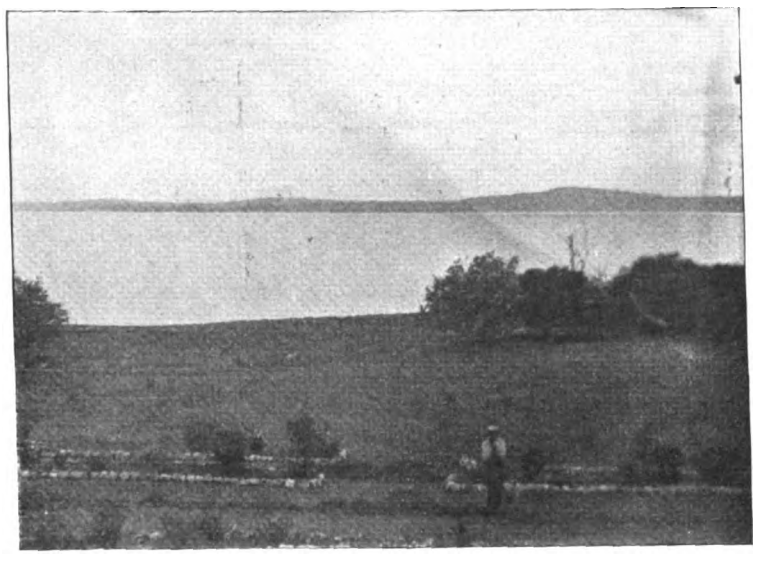
By JOHN PLUMMER, Sydney.

SEVERAL of the Australian inland lakes possess a certain amount of scientific interest by reason of curious phenomena associated with them. Among these is Lake George, so called from the last British monarch of that name, and situated in the heart of beautiful country forming the south-eastern portion of the State of New South Wales, a district favoured by many Australians as a site for the projected Federal capital. The lake lies, as it were, in the basin of an extensive plain, with a magnificent background of hilly ranges, and is about twenty-one miles in length, with an average width of between seven and eight miles.

An Australian Lake.—View I: Before the Expansion.

The average depth is about twelve feet, but in places where clefts in the bottom are believed to exist it is considerably deeper. Mountain chains enclose the lake on either side, rising in grassy slopes from the water's edge, and assuming vaster and vaster proportions as they recede from it. At each end the country is comparatively level, but considerably above the level of the lake, which thus forms an immense natural reservoir capable of supplying by means of gravitation, being 2,120 feet above sea-level, the low-lying districts in the vicinity with an abundance of water for irrigation and other purposes.

At the time of its discovery the lake was a broad sheet of water, but some few years later it became dried up, and in 1851, the year of the



An Australian Lake.—View II. Taken from the same point as View I.

Australian gold discoveries, it was occupied as a sheep and cattle station, feed, in the shape of salsolaceous plants, often attaining a height of several feet, being abundant. In 1852 there was a great flood at Gundagai, several miles distant, involving considerable loss of life and property, and the dry beds of the creeks running in the direction of the lake became filled with such immense volumes of water that within a few weeks the lake had resumed its old appearance. Fortunately, the station managers, acting on the advice of the residential aborigines, removed their property and live stock directly the creeks began discharging their contents into the lake. Many of these creeks are of an auriferous character, and at the time of the flood furnished remunerative employment to large numbers of gold-diggers, and even now fair quantities of the precious metal are procurable where the streams are shallow enough to admit of working operations being carried on.

From the fact of the lake having no outlet, its waters, we are told, are saline, though fed only by fresh water streams, the seeming anomaly being explained by the accumulation of salt in solution, passed into the lake by drainage from the basaltic rock, and not to the presence of any inherent saline matter. The absence of any outlet causes the annual inappreciable quantity of saline drainage to accumulate in the lake, while the amount of water, being kept down by vaporation and absorption, remaining for lengthened periods approximately the same, the percentage of salt naturally shows a yearly increase. Similar instances of saline lakes fed solely by fresh-water streams are to be found in other parts of the Commonwealth, especially in Victoria. Although the water is too salt for human consumption, sheep and cattle drink it freely.

Within a few years of the lake becoming filled up it was found to have become the resort of incredible numbers of wild ducks, pelicans, "spoon-bills," and other aquatic birds, "red-bills" and "water hens" congregating in thousands on the more sequestered portions of the shores, while the "native companion"—the name given to an Australian bird—assembled in such myriads that the farmers in the neighbouring townships were compelled to poison them by wholesale. There are large quantities of fish, especially the "Murray cod," which have been caught at eight lbs. and ten lbs. weight, the progeny of some fish introduced by a pastoral resident. But the presence of a large animal, resembling a seal, which rises occasionally to the surface for the purpose of breathing, still remains a mystery. At present, in consequence of the recent protracted drought, the waters of the lake are considerably below their customary level.

Power-Signalling on English Railways.

By CYRIL HALL.

REFERENCE has been made on more than one occasion in the pages of the "ILLUSTRATED SCIENTIFIC NEWS" to the introduction on some of the leading railway lines of the United Kingdom of various ideas dealing with the signalling problem. Most of these ideas have emanated from America, and some of them have been worked into more or less tangible systems. As there can be little doubt that the railway signalling problem can only be solved by the abolition in a great degree of the human element, and as this is the main feature in favour of the automatically operated signal, probably a few years hence—when the great suburban systems have been electrified—compressed air, or electricity, or possibly water will rule the road, and the cumbrous levers and dangerous wires of to-day will take their places in the great history wherein is written the romance of the railway. It has frequently been argued in the untechnical Press, in favour of power signalling, that since the American lines find the various systems in use there to work so satisfactorily that the manual systems are rapidly dying out, it follows that these systems would be equally useful on English lines.

A more ridiculous mistake than this comparison it would be hard to imagine. American conditions of railway working are so re mote in every respect from those extant on this side of the Atlantic—and this remark particularly applies to all signalling devices—that there can be few instances where Anglicising would not probably be more difficult, and their adaptation to our modes of working more complicated, than would justify their importation. So far as this very complex problem is concerned, this is in a sense, for us, a transitional period. And at the close of a year which has seen some important railway moves in the direction of progress, it will not be out of place to give a brief review of the more important of those systems with which British signalling experts have been experimenting.

The Question of Power.

By what means can the automatic signal be most efficiently and economically actuated? This is naturally the first question the railway company which intends departing from the old order must ask. Very few of millions of persons who are annually carried through the 58,000 square miles which contain our country come to serious harm; and when a railway accident does occur, the Board of Trade, when it reports on the accident, can fill pages with condemnatory remarks concerning the slow action of the *English* brakes, or the primitiveness of the *English* signalling system, which all tends to point to the perfection of foreign inventions; but the Board of Trade excellent institution though it be, can never offer a suggestion of remedy for the multitude of defects it can find.

Compressed air, used in conjunction with electricity, has advocates in this country. It has been said against the pneumatic principle that signals so worked can only be carried out in short sections, as an even pressure cannot be maintained in pipes of great length; that it is subject to fluctuations of temperature; that joints and connections in the conduit pipes are liable to leak; but perhaps the most weighty argument against the application of pneumatics lies in the initial cost connected with the installation of the necessarily large number of compressing plants required where any

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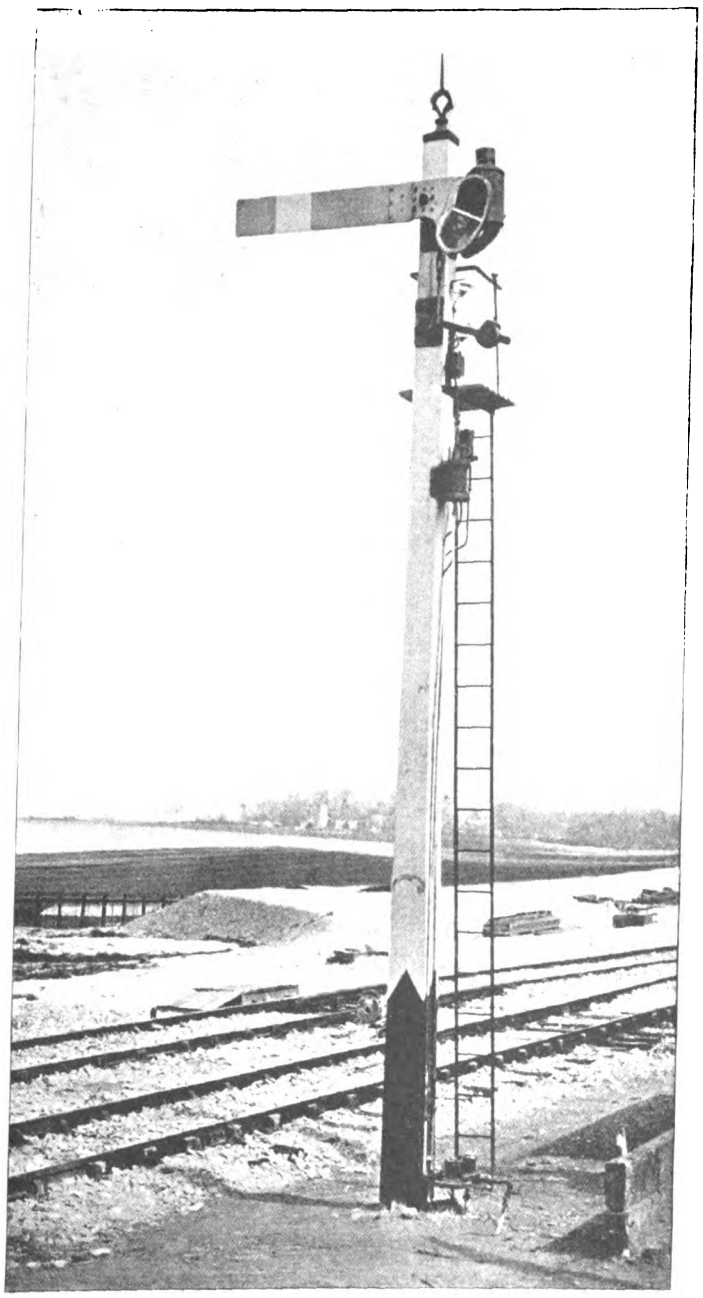
length of line is to be worked. But a great point in its favour is the simplicity of the system. As will be pointed out hereafter, the actuating force, whatever form it may take, is generally controlled by electricity. For this reason there should be a future for the "all-electric" systems. Strangely enough very little has been done in this direction, and at present there are only two railways in this country which have taken the "all-electric" in hand. In big towns—and, indeed, in many small ones where electrical power is to be easily obtained—little difficulty should stand in the way of its adaptation to signalling purposes. When generators would have to be installed to supply the necessary current, as would be the case in remote, out-of-the-way places, electrical working of signals is obviously out of the question.



A Modern Power Operated Semaphore: British Pneumatic System.

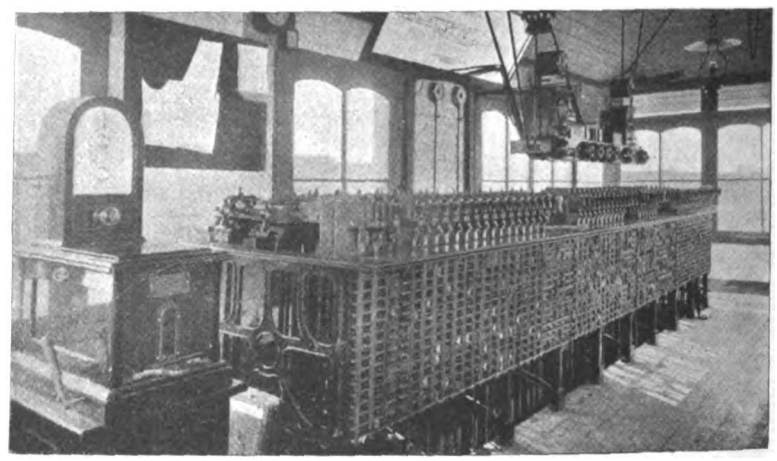
Experts differ on the question whether the automatic systems can ever come regularly into vogue in England, owing to the complicated network our railways form. But the fact that several very busy and important junctions are already equipped with power signals rather belies this assertion. All are agreed, however, that when installed on lines free from large junctions the advantages of the power-operated signal are very great; for, apart from the decrease in staff and wages, the relief of mental strain, and the consequent elimination in a large degree of the human agency—which, however perfect the block system may be, is, unfortunately, not infallible—the carrying capacity of the line is considerably augmented, and it runs little risk of interruption from severe snowstorm or gales, which are liable to cripple the ordinary method of signalling with its exposed wires.

Little appears to have been achieved with hydraulics, the most docile and irresistible of natural forces. Perhaps in this case the question of expense is the main drawback. The charge that in winter comparatively low pressure water power, conducted in small mains, is liable to fail through freezing is, of course, a fallacy. With the addition of glycerine or spirit, water is, at all events in our climate, irrefreezible. In the Hall system of automatic signalling—sometimes called the "banjo system"—gas is used as the actuating agency, and although the North-Eastern Railway a year or two ago carried out experiments with this invention, little has been since heard of it.

"Time" and "Space" Signals.

Without going in any way into technical details, it may be of interest to briefly describe, from an historical standpoint, those earlier experiments with labour-saving appliances for the signalling of trains which were the crude beginnings of the now more or less perfected systems. Needless to say, any innovation which was to improve on the theoretically perfect "absolute block" system was viewed aghast by the majority of English railway engineers. In the early sixties, which was about the period when automatic devices were beginning to have a growing hold on American railways, the American engines and inventions which had been before this time introduced on to some of the leading lines in this country had had none too glorious careers. Consequently the reckless progressive policy of the Americans was not very favourably regarded through conservative British glasses.

The first step in the direction of progress lay in self-acting signals giving an interval of time or an interval of space, and probably the first practical demonstration of the possibilities of self-acting devices was made about forty years ago by Mr. Baronowski, of the North London Railway. This gentleman experimented with a mercurial column, which was filled or emptied by the movement of a lever actuated by the wheels of a passing train. The mercury passed into a column through a valve released by a piston, and as it dropped through a small aperture, the descent of the mercury in the glass operated a signal which could be seen by the driver. In 1864, Mr. Funnell made a series of experiments with "space" signals on the Brighton section of the London, Brighton, and South Coast Railway. In this invention a passing train moved a lever attached to the rail, and put a signal at A to danger. When the engine arrived at B, it put a signal at this point to danger, and the same motion, by means of an electrical contact, completed a circuit which passed an electric current through an electro-magnet at A, and thus released the A signal. In like manner the same operation was repeated at C, this signal being put to danger and the last one passed (B) to safety. These signals were used for some time, and apparently worked satisfactorily, though they were finally abandoned, presumably, so it has been reported, because the wires were constantly either purposely or accidentally broken. Funnell's system did not provide for any interlocking arrangement. Soon afterwards the "treadle" systems came into vogue. The electric treadle is still used, generally on short sections of track, and is a method of protecting a train which has been admitted into a section, the signal governing the section being locked by means of the treadle inside the signal, and held locked until such time as the train has passed over another treadle holding the signal of the next section.



Low Pressure Pneumatic Interlocking Machine.

Apparently this would seem sufficient protection, but supposing part of a train passes over the treadle, leaving the other part of the train on the line "inside" the signal, the fact of the first part passing over the treadle releases the lever thus governed in the frame, warning the signalman that he may pull off his signal for the next train. In this case it will be seen that a collision might occur between the train following and the half of the train left in the section. This points very forcibly to the fact that a signal lever in the cabin must be held without any possibility of being released so long as there is any part of a disabled train standing under the protection of a signal. The obvious remedy is a continuous treadle, extending from one signal to the next. We shall show, later on, that the only practical way of accomplishing this is by electrifying the rails themselves—in other words, "track circuit" must be employed. Where electrical track circuit is used the possibility of rear-end collisions is practically eliminated—except, of course, when the engine driver deliberately passes a danger signal.

Pneumatic Systems.

It is the electro-pneumatic signal which has the greatest vogue in this country. Of the several schemes which we shall endeavour to describe—all of which have points in their favour—the Westinghouse is the best known and longest tried. The Westinghouse electro-pneumatic system has passed the experimental stage, and though, of course, it is being improved year by year, and is

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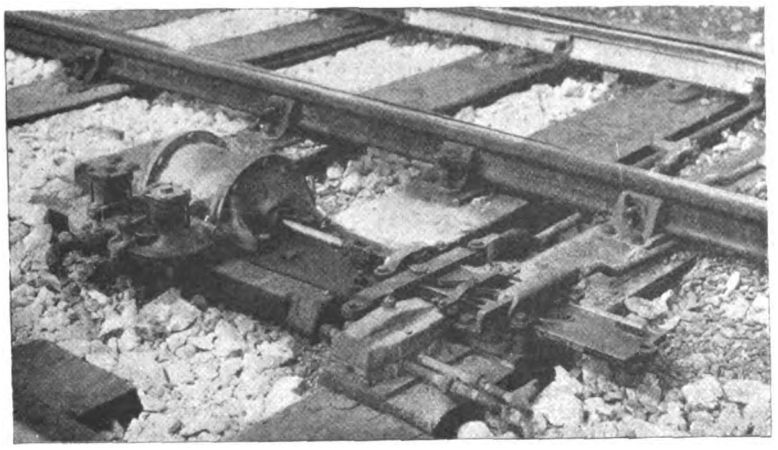
being continually adapted to different modes of working on various railway systems, it may justly claim to be responsible for the introduction of practical power-signalling into England. From motives of space we shall be obliged to deal with the Westinghouse system in a separate article.

In 1901, Mr. Sam Fay, who was then superintendent of the line of the London and South-Western Railway, recommended to his Directors, as the outcome of an American tour, that the British Pneumatic Railway Signal Company's apparatus should be installed on the South-Western line at Grateley, an important junction on the Exeter main line. This is a system of inter-locked signals and points operated by low-pressure air. Some of the main characteristics of this system are that it requires a low air-pressure—about 15 pounds to the square inch; that except when a lever is being actually used to operate points or signals this pressure is withdrawn,



Point Motor as used on the L. & S. W. R.

and the apparatus and conduit pipes are subject only to atmospheric pressure; that, since the final stroke of the lever in the frame is automatic, it is only the admission of air that requires the attention of the operator, and much heavy manual labour is thus abolished. Moreover, since an indication or "return" is always given, it follows that in this system, as in others, the signalman can devote more attention to the opening and closing of his sections; and need not be anxious concerning the failure of a certain signal to work. The cardinal provision is made that in case of absence or failure of the power—which seems remote—an affected semaphore will return to the "danger" position. Positive application of power is in every case necessary to move a signal or switch. The increased safety and quick action of the pneumatic movement has induced the Board of Trade to sanction a valuable increase in the distance over which signals and facing points may be worked. The L. and S. W. Ry. have, in addition to the Grateley installation, pneumatically worked signals at several other places on their line, including busy sections at East and West Staines. One great advantage arising out of the saving of labour is the more thorough concentration of lever frames, in many cases one cabin taking the place of two or more necessary for the old mechanical system. The essentials of the British Pneumatic Signal Company's apparatus may be said to consist of a diaphragm valve, main valve, and indicating valve attached to the operating bar or lever, air compressors and reservoirs, and the switch and signal movements. The necessary power can be supplied by a small gas or oil engine. It will be unnecessary to enter into technical details, as our illustrations and diagrams explain themselves.

Track Circuit.

As already mentioned, when "track circuit" is employed, the safety and efficiency of the pneumatic system is considerably increased. Since the maintenance costs no more than that required for the electric treadle, and the effect of replacing a lever and holding it in the normal or "back" position by the passing train renders the train to a certain extent independent of the signalman, or, in other words, protects itself, this will be readily understood.

Owing to the small insulating resistance of the track itself, the electro-motive force has to be very low, and is never greater than 1·5 volts. Thus there is little leakage. The current on the track, unlike the air, is always operating. In the British Pneumatic Company's system all the circuits are kept separate, so the failure of one circuit will not interrupt the others. This is a point which, in some all-electric systems, has not received much attention, as cases have been known of a single leakage locking up a whole machine. The electrical relay, the electro-pneumatic valve, and the electro-pneumatic cut-off valve are the vitals of the track circuit when used with the low pressure pneumatic. The relay consists of an electro-magnet, which, when energised, attracts an armature. To this armature is attached a circuit closer spring, and whether this is open or closed, thus making or breaking the circuit, depends on whether the magnet is energised or not. The electro-pneumatic valve consists of a simple electro-magnet, on the top of which is fastened a valve. This and the electro-pneumatic cut-off valve are very similar in construction, but their functions are totally opposite. The electro-pneumatic valve is so designed that when the magnet is energised and the armature lifted, the ports in the cylinder are open to admit air through the valve, and when the magnet is de-energised these ports are closed.

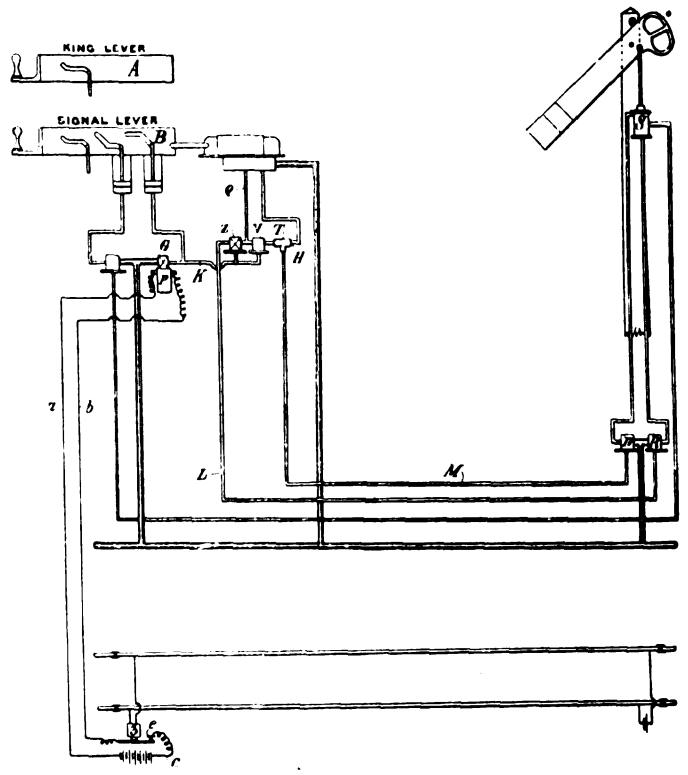


Diagram showing Electro-Pneumatic Signal Connections.

The action of the electro-pneumatic cut-off valve is, as has been mentioned, exactly opposite to this, and in the first-named condition the ports are closed, and when the magnet is de-energised, the ports are open for the passage of air.

The Crewe System.

The Crewe System, the most important of the all-electric, has already been described at some length in the columns of this journal. The result of the combined efforts of Mr. I. A. Zimmis, the inventor of the long-pull electro-magnet, and Messrs. Webb and Thompson, the patents for the Crewe system are exploited by the Railway Signal Company, of Fazakerley, Liverpool. In addition to the installation at the Crewe Sidings, the North-Eastern Railway have recently adopted this form of electric-power signalling at an important junction near York. The installation at Crewe, which has been in operation for four years, consists of motors for working the points and electro-magnets for working the disc and semaphore signals, the current being derived direct from the lighting mains at 110 volts. Except in the largest cabins, where there are frames of 200 levers, twenty-five amperes at 100 volts is said to be the maximum demand. It will thus be seen that the amount of power required is extremely small. The motors for moving the points work with a cam and worm, the mechanical parts working in a bath of oil. The signal cannot be lowered, or electrical connection made with the solenoid for working the signal, until the point is locked in position. When it is desired to move a point, the handle or switch in the frame is pulled about half-way over and stopped by a detector. This motion makes a connection with the motor through a carbon break switch. The motor rotates and carries the point over. Until this has actually been done, the return current is not sent back to the cabin through the detector, and the operator is, therefore, unable to complete the full throw of his handle and lower the signal. When, however, the point is locked, electrical connection is made through a solenoid which releases the lever and the signal can be placed at safety. As the boxes which contain the motors and detectors are sunk to the level of the line, they form no obstruction or danger to shunters. Another important advantage is that, with electricity as the motive power, a greater distance can be safely and rapidly worked over. Another all-electric system is the Taylor, which is now being experimented with in Scotland.

Signals for Single Tracks.

On most single lines in this country the traffic is not very heavy, except at stations where the up and down trains have to pass. On such railways the signalling is carried out on what is known as the "staff" or "ticket" system. One of the most popular staff devices is the Webb and Thompson patent electrical train staff instrument manufactured by the Railway Signal Company. Although scarcely coming under the category of power signals, it is worthy of notice, since the locking of the staffs is accomplished by electricity. Several thousands of these instruments are in use on some thirty-five railways in the United Kingdom, and the system is extensively used abroad. For purposes of explanation of the working of the instruments let it be assumed that there are two sections: A—B, B—C. One instrument is required in cabin A, two instruments in cabin B,

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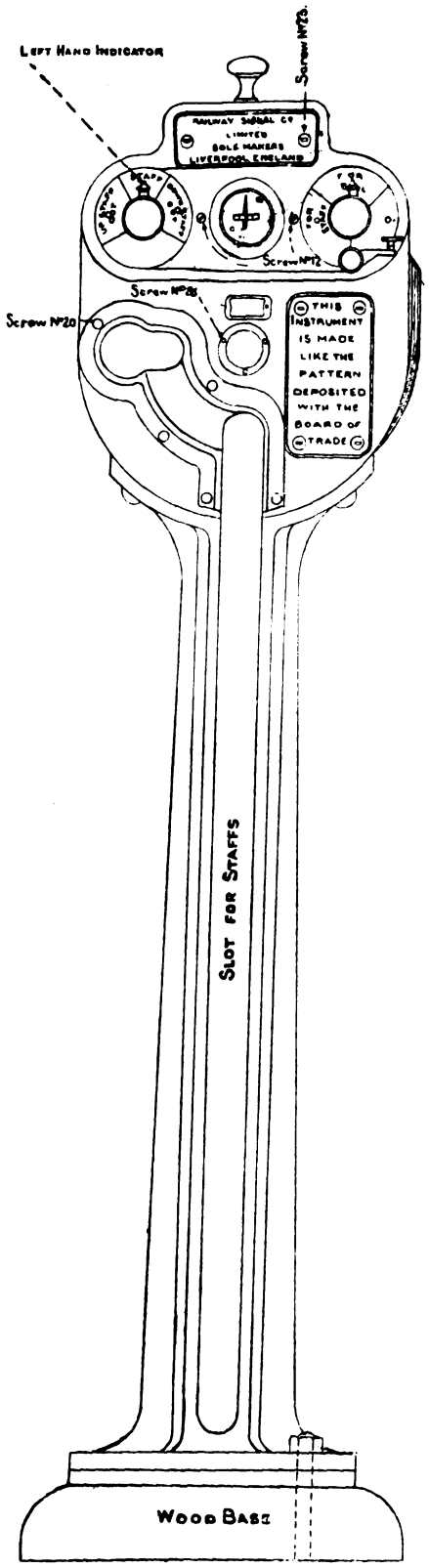
and one in C. The staffs for use between A—B will not enter the instrument for section B—C, and similarly the staffs between B and C will not enter the instrument A to B. Each instrument contains as many staffs as may be required, but only one staff may be withdrawn for use on a section at one time, and this staff must either be replaced in the instrument from which it was taken or carried by a train to the further cabin, and deposited there, before it is possible to withdraw another staff in this section. Supposing that a train is ready to start from A to B, the signalman at A gives B warning, and when B has acknowledged this warning, A gives a description of the train about to travel, and asks for permission to withdraw a staff, turning his dial pointer to "for staff." A can now unlock his staff,



The Webb and Thompson Electrical Staff Instrument.

which he hands to the engine driver, who proceeds with it to B, where it is deposited in that instrument, and he receives the staff for section B—C.

Another instrument for the working of single lines is the self-acting "tablet" machine recently introduced by Messrs. Tyer and Co., Limited. It is worked by the guard of the train, who, when he wants to enter a section, goes to the machine and ascertains from the indicator whether the section be blocked or free.

The Application of Carbonic Acid Gas.

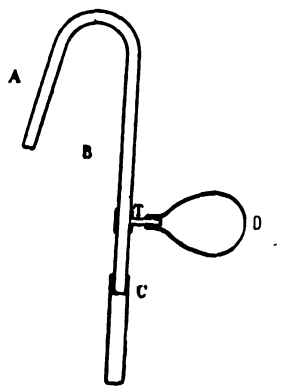
The North Eastern Railway Company have equipped a short section of their line with automatic signals on the Hall Electro-gas principle. In this instance liquid carbonic acid gas is stored at the base of the signal post. The compression is equivalent to about 800 lbs. per square inch, which is brought down to a working pressure of about 40 lbs. by a reducing value. The cylinders or motors are similar to those used for compressed air, and the admission of the gas is controlled by the armature of an electric magnet, which is energised by a track circuit relay. The Hall method has some exponents in America, but there are many difficulties in the way of its general adoption in this country.

The Miller Cab Signal.

The Miller system, introduced into England from the United States by the British Miller Signalling Company, may be said to be the latest development of the question, and a short length of track at Woodhead, near Manchester, on the Great Central line, is thus worked. It is an ingenious device, but it is extremely doubtful whether it will be found useful for practical working under our existing conditions. The Miller system essentially consists of signals, which take the form of red and white lamps, placed in the cab of the locomotive, these lamps being operated from a track circuit. Electro-magnets on the engine, deriving their current from track batteries, make or break the track current, and automatically bring into circuit power from a small dynamo run on the engine. When the two sections in front of a train are clear, the current passes through one end of the armature and lights the white lamps; but if either of the sections is occupied by a train or in any way obstructed, the current goes through the other magnet and illumines the red or danger lamp. As may be readily conceived, the cost of equipping all the engines on a railway with the rather elaborate apparatus required for the system would be very great, especially if, as one may suppose to be the case, the Miller signals are only to be used as an auxiliary to the existing system. For it is almost outside belief that they should replace the fixed signal. But the advantages are also very great. The driver need pay little attention to matters outside his cab, and his signal is always within his view. Thus the inconvenience and danger of a driver of a rapidly-moving train of say two hundred and fifty tons—perhaps on a down grade—suddenly coming into sight of a danger signal which was obscured by a bridge or a bend in the line is practically obviated. Of course, it must be understood that such a contingency as this is now-a-days remote. Again, in cases of fogs, the expense of picketing fog signal men throughout a line is reduced to a minimum, for the cab-signal cannot be interfered with or obscured by atmospheric conditions. It is as a step towards the solution of the fog problem that the Miller system should be most useful.

Syphon for the Decanting of Dangerous Liquids.

THOSE of our readers who have to deal with primary or secondary electric batteries, or with electrotyping or photography, or electro-chemistry generally are frequently obliged to handle acid or saline solutions, whose contact with the mucous membranes may be very injurious. This may be obviated by the use of the automatic syphon, which we now proceed to describe. For emptying a battery it is necessary to make use of a syphon drawing in automatically the bichromatic solution of the acidulated water. The following apparatus, which is quite easy to construct, can be used in many cases in which dangerous liquids have to be handled.



Take one metre of lead gas-piping, 12 millimetres in diameter, bend it in the form of an arc of a circle whose radius is about 6 centimetres so as to obtain two ends A and B of unequal length. The shorter end should be 35 centimetres, a little more than the height of the vessel containing the liquid. At 20 centimetres from the lower end of the longer end solder a little tube T, to which an indiarubber pear-shaped syringe D can be fitted, such as can be bought at any chemist's. A piece of indiarubber tubing C should then be fixed at the extremity of the longer end of piping. To make the syphon draw place the short end in the vessel to be emptied, squeeze the syringe so as to exclude the air, closing at the same time the indiarubber tubing by pinching it with the finger and thumb. On letting go the syringe the vacuum thus caused sucks up the liquid into the syphon, and on letting go the indiarubber tube the liquid runs through it into a vessel that one should have ready; a wooden pail varnished with bitumen does perfectly.

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The Function of Mucilage in Plants.

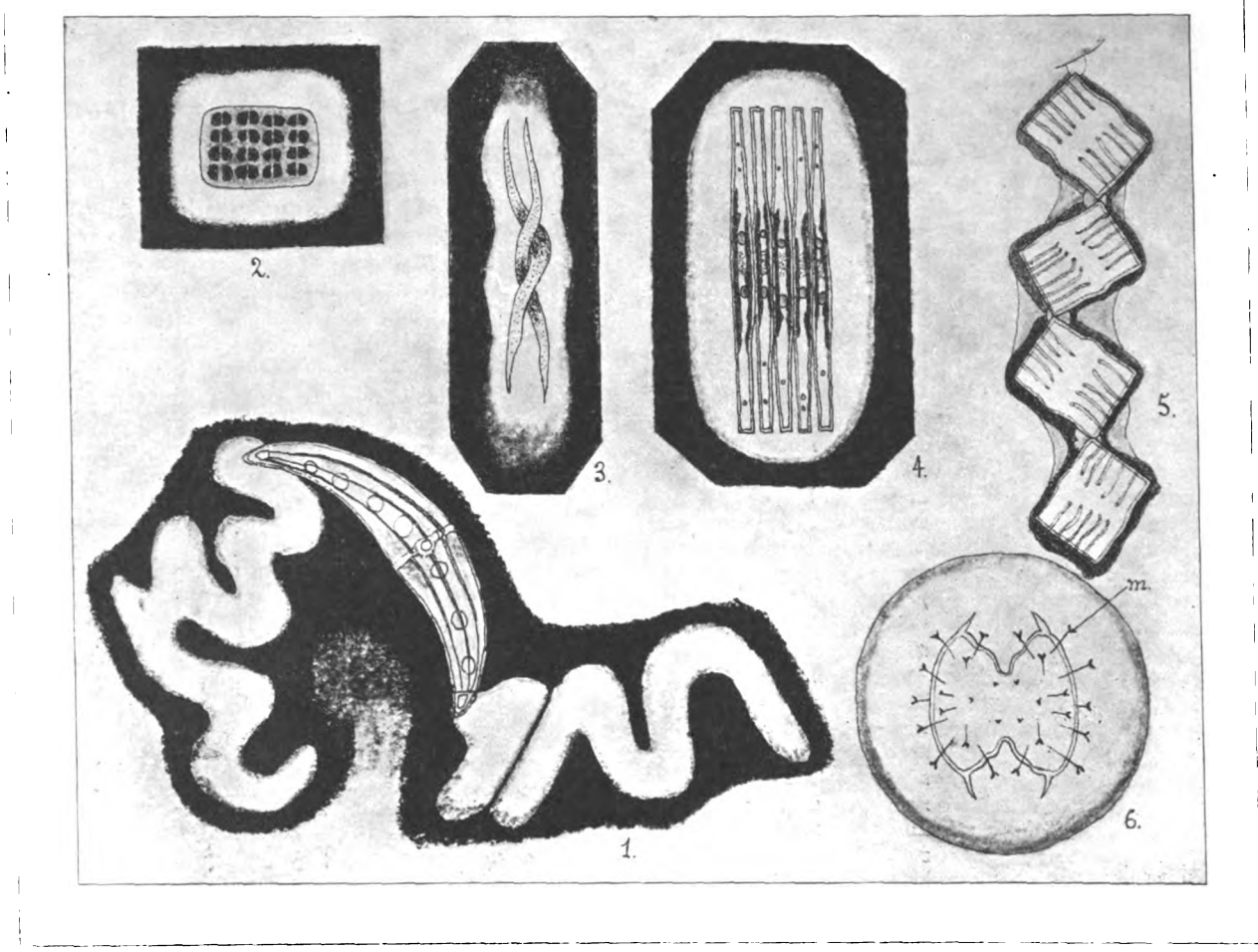
ORGANISMS, which, during the whole period of their life, occur in water or damp localities are to a great extent more or less completely covered by mucilage. But even in terrestrial plants and animals mucilage is frequently found—here generally in the interior of the organism (*e.g.* mucilaginous sacs in the interior of Orchid tubers), although very common in the epidermal cells of many plants; amongst animals it occurs in the mucilaginous membranes of the respiratory passages, etc. The mucilage is in most cases transparent, very commonly so much so, that it is not apparent in the absence of special treatment. Such mucilage is rendered very distinct by placing the objects in question in a drop of diluted Indian ink; their margins are then separated from the dark mass of ink by a clear area (*cf.* Figs. 1, 2 and 4), occupied by the mucilage, which not rarely forms more than one distinct layer of varying consistency (two layers in Figs. 2 and 3). The latter is developed in two ways; either it is formed by the protoplasm of the cell, or the cell-membranes become in part or entirely transformed into mucilage. In the former case the mucilage mostly reaches the exterior by pre-formed pores in the cell-membrane, as is the case in the Desmids (Fig. 6), the mucilage just outside the pores being of a much denser consistency and commonly having a very characteristic shape (Fig. 6 m.).

Looking at mucilage from the biological point of view we find that it subserves various functions. In the case of frogs' eggs, for instance, each of which is surrounded by a well-marked layer of mucilage, this latter, besides serving as a protection against mechanical injuries, acts as a lens in the taking up of the heat-rays of the sun, for which the coloration of the egg is especially adapted; the action of the mucilaginous investment may here be compared to that of a hothouse. In the case of many Algæ the enveloping mucilage is a safeguard against chemical and physical changes in the surrounding medium; many substances are incapable of diffusing through mucilage, and in this way a large number of aquatic plants are protected from injurious or poisonous constituents occurring in the water in which they live. Many Diatoms only form a mucilaginous investment (Fig. 4), when decrease in the amount of water present causes a concentration of the salts in the surrounding medium. The young parts of many aquatic plants are enveloped in mucilage, which serves to prevent their coming into direct contact with the water. In these plants the mucilage thus has very much the same function as the cuticle of the higher land-plants, this latter being a specially differentiated layer in the outer walls of the epidermal cells, which is very resistant against chemical influences.

Many of the Algæ and Bacteria inhabiting damp localities would repeatedly stand in danger of desiccation, if it were not for the well-developed mucilaginous envelope which they possess. Most readers will be familiar with the thick gelatinous clumps formed by the blue-green Alga, *Nostoc*, and in every damp hot-house large numbers of similar forms will be found covering the walls. The amount of water (taken up in the fluid or vaporous state) retained by these mucilaginous investments is very considerable; such Algæ have been kept for four months in an absolutely dry locality without losing all the contained water. These aërial organisms are, as it were, amphibia amongst plants; they have left the water to live in the air, but in their mucilaginous investment have retained an aqueous reservoir, which saves them from drying up.

Mucilage, however, has many other functions. In some cases (*e.g.* many flat Diatoms, such as *Cocconeis*, which live in large numbers attached to the surface of many aquatic plants), it serves to attach epiphytic individuals to the substratum. Further, it may assist in the motion of many organisms, notably of some Algæ and of the Gregarines amongst the animals. The way in which the motion of the little Desmid, *Closterium*, for instance, takes place is very illustrative (Fig. 1). If an active individual of this genus is placed in a drop of diluted Indian ink and observed under the microscope for some time, a small cap of mucilage is first seen to be formed at one end of the semilunar cell; this mucilage gradually increases in amount and becomes firmly attached to the substratum. Continued excretion ultimately gives rise to a convoluted mucilaginous stalk, whilst the *Closterium* slowly moves away from the point at which the formation of the mucilage first commenced. When the one end of the cell is exhausted the other begins to form mucilage in the same way, and motion takes place in an entirely different direction. The immense amount of mucilage excreted in this way will be perceived by a glance at Fig. 1. By this means many Desmids and other Algæ can slowly work their way up out of the mud or out of enveloping masses of other aquatic plants, so as to obtain the amount of light necessary for their assimilation; or this gradual motion serves to bring them into aqueous layers, containing a greater amount of oxygen.

Finally, mucilage in some cases also undoubtedly acts as a protection against the voracity of animals. Thus, Stahl has shown that snails are unable to attack a number of Algæ and other aquatic plants, owing to the small teeth on their radula being unable to obtain a firm grip of the enveloping mucilage.



Mucilage of Plants.

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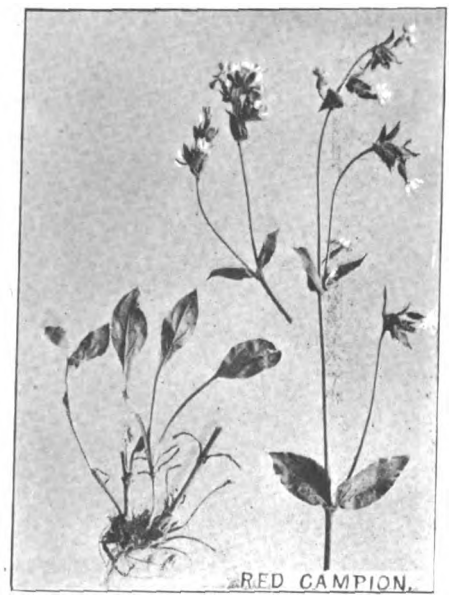
The Natural History of British Wild Plants.

By J. C. SHENSTONE, F.L.S.

V.

THE characters used by the writers of our "floras," in describing families, genera, and species, frequently appear to be those which are of no special use to the plants, or only of indirect use, being selected because they happen to lend themselves to the purpose of descriptive botanists. Plants are highly complex organisms, and



our knowledge of their life history is even now limited. The characters more particularly selected by descriptive botanists are the structure of the flower, and the forms and arrangement of leaves and other parts of the plant. Although these may not individually appear to serve any direct purpose, yet the details of plant structure are subordinate to the form and habit of the plant as a whole, and this invariably adapts itself to its environment. Apparently unimportant characteristics may be co-ordinated with others essential to the plant's well being.

We must not overlook the fact that plants possess many other characteristics which are as constant and reliable as those used in our floras. In time we become so familiar with plants that we know them as we know our most intimate friends and relatives, whom we should recognise after long intervals, when their hair has changed colour, and their features have so altered by age that it would be impossible to tell how we recognised them. The following instances may serve to further illustrate this subject:

Fond as I am of wild plants, there is one small plot of ground at the back of my house upon which all wild things are treated as inveterate enemies, and allowed no quarter. Recently, noticing some young leaves, which at first sight appeared to be nettle leaves, I proceeded to pluck them up, but in so doing my attention was arrested by a strong and peculiar odour, so distinctive that I recognised it as an old world plant called Balm (*Mellisa officinalis*), in spite of the fact that I never happened to have seen the plant before, and had only a few leaves to guide me. Again, who could not recognise lavender by its odour, yet the odour of a plant is of little use to the descriptive botanist; it is so difficult to define in words.

We have learnt that the crowfoot plants are mostly irritant poisons, or narcotic irritants. That poppies are mostly narcotics. That plants of the cress family are all wholesome, but are apt to be pungent like mustard and cress. The pink family, which I shall next describe, is peculiar in the fact that most of its species contain an unwholesome principle called saponine, which occurs in very few plants not belonging to this family. Such characters are, however, in practice of very little use for descriptive purposes, for they can only be detected by submitting the plants to chemical analysis, or by running some risk of poisoning oneself.

Plants are often attacked by fungi, and these often confine their attacks to certain species of the higher plants only; sometimes, at different stages of their growth, attacking different plants. The barberry blight, already alluded to, affords an instance of a fungus which attacks the barberry at one stage of growth and some species of grass at other stages.

The gall insects select special plants in the tissues of which to deposit their eggs. They appear to recognise by instinct the external characters of the plants which provide the necessary conditions for rearing their progeny.

From these and similar facts we learn that the outward forms of plants are co-ordinated with differences in their internal structure, and in their physical and chemical constitution, and that the resemblance which plants of the same family bear to one another indicates, in fact, blood relationship.

The Pink Family (*Caryophyllaceae*)

is, like the Cress Family, a very uniform family, and its members may also be divided into two sub-families. In one, the outer floral whorl (*calyx*) is combined into a tube, down which only insects with long proboscides can reach the nectar. In the other the parts of the outer floral whorl are separate, exposing the pollen to attacks from all insects. The flowers of the former are either of some bright or variegated colour or pure white, and their petals large, otherwise they would not be discovered by the few insects which can serve them for cross-fertilisation. Some of the species with white flowers expand their petals and give off perfume only at night, obviously relying upon night-flying moths for carrying their pollen from plant to plant. One species actually rolls up its petals in the day time, saving both its perfume and its beauty for night-flying moths, becoming very inconspicuous during the day time. The plants of this sub-order are usually protected from visits of such insects as are useless or even mischievous to them by very viscid stems, and are called, popularly, "catchflies."

The chickweed sub-order has, on the other hand, inconspicuous flowers, their honey being accessible to all insects. These flowers are very often self-fertilised in the bud (*cleistogamous*) or the anthers touch the stigmas at the end of their flowering period, securing self-fertilisation in the event of insect visitors failing them.

The only use plants of this order are to man is for decorative purposes. Most of them contain an active principle (saponine), rendering them unpalatable and unwholesome. Saponine is, however, destroyed by heat.

Those plants of this family most appreciated by gardeners are the "pinks," which are represented in the British flora by four species.

The Maiden Pink (*Dianthus deltoides, Lin.*),

which received its name in mistake for "mead pink."

Its stamens and petals spring from a ridge of the receptacle encircling the stalk of the ovary, on the inner border of which is a yellow cushion secreting honey. The pistil, stamens, and stalks or claws of the petals are enclosed in the tubular calyx, a very small passage being left leading to the honey, and this is blocked by the five inner anthers, so that lepidoptera only can reach the honey. As soon as the flower has expanded, the anthers protrude

in rapid succession, covered all round with pollen, and every butterfly visiting it must carry away some of the pollen grains. The stigmas emerge only after all the stamens have withered; pollen can, therefore, only reach them by the agency of the butterflies.

The Clove Pink or Wild Carnation (*Dianthus Caryophyllus*)

has become naturalised upon some old castles, walls, etc. It was called "Sops in Wine" from wine being flavoured with it. Chaucer says:—

"There springen herbes, grete and smal,
The licoris and setewale,
And many a cloue gilofre—
To put in ale—
Whether it be moist or stale.

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The Soapwort (*Saponaria officinalis, Linn.*)

is also a naturalised plant. Gerard tells us, "it groweth wild itself near to rivers and running brooks in sunny places," but he also tells us that it was planted in gardens "for the flower sake, to decking up of the house, for such purpose it chiefly serveth."

This plant contains so much saponine that it froths when bruised, and is used as soap. Kerner tells us that the field mice at Innsbruck once caused great damage under the snow by gnawing various roots, but the roots and rootstock of saponaria were left untouched by them, protected by the saponine.

The Sea Campion (*Silene Maritima, With.*) and Bladder Campion (*Silene cucubalus, Wibel*)

are considered by some botanists, varieties of the same species. The Sea Campion occurs upon our sandy sea shores, and also upon mountains 3,000 feet high, its place being taken by the Bladder Campion on the sandy soils on the intermediate heights. The Bladder Campion has less conspicuous flowers than the Sea Campion, and its calyx is swollen almost to a globular shape, and is bladder-like in appearance. The latter plant is one of the plants which have established themselves upon the American continent, the fields along Hudson's River being overrun with it. The scales attached to its petals have been known to bear stamens.

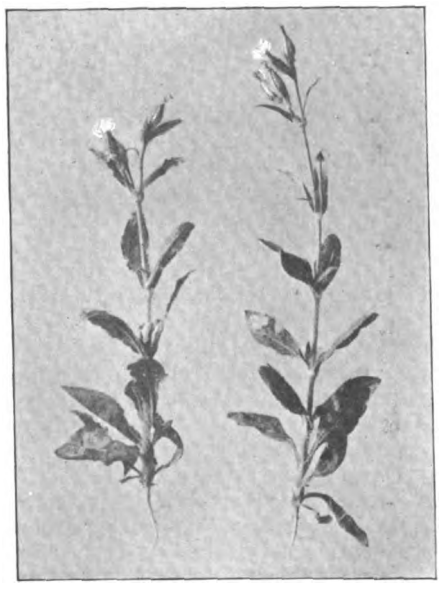
The Nottingham Catchfly (*Silene nutans, Linn.*)

is one of the most interesting plants of this order. The upper part of its stem is peculiarly sticky, and serves to catch insects which would otherwise rob the flowers of their honey, without serving them in any way. Kerner has collected 60 species from these sticky stems alone.

The flower is peculiarly unattractive in the day time, its petals being then rolled up; but at night they unroll and form a reflexed white star, very conspicuous to night-flying insects. The flowers, at the same time, develop a strong odour. Five anthers are also excerted from the flower, which quickly discharge their pollen, and remain covered all night with sticky pollen grains. The following morning the petals roll up again, and the second whorl of stamens are excerted and become covered with pollen, and at dusk the petals spread themselves out. On the third morning they roll up, doing so faster on sunny mornings than in dull weather, and at dusk they unroll, but this time the long velvety stigmas protrude, ready to receive the pollen brought by insects from other flowers, their own pollen being now exhausted. The outside of the petals is reddish in colour, and being inconspicuous, it would be useless to attract insects in the daytime, when neither anthers nor stigmas could profit by insect visits.

The Night-flowering Catchfly (*Silene noctiflora, Linn.*)

also unrolls its petals at night, and its upper leaves secrete viscid



Night-flowering Catchfly (with petals unfolding).

matter which catches creeping insects, but this plant has not been so carefully studied as the last one.

One of the commonest of our wild plants is the

White Campion (*Lychnis vespertina, Sibth.*).

It has been called many other names. The name Bachelors' Buttons was given to it in consequence of its being one of the plants carried by countrymen in their pockets in order to judge as to their success with their sweethearts. It augured well if the plant continued to grow. Shakespeare says in "Merry Wives of Windsor":—

"'Tis his buttons, he will carry it."

This custom was common in Shropshire and Staffordshire comparatively recently. The name Campion is said to have originated from a plant of this genera having been used in the chaplet with which the champions were crowned at public games. Other names for this plant are Bull Rattle and White Robbin.

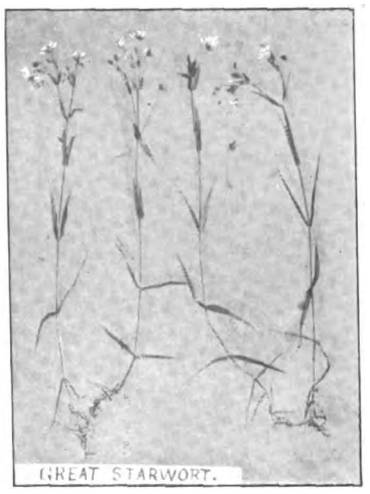
The flowers are not so highly specialised to attract night-flying insects as the Nottingham Catchfly, but it emits perfume only at night, which, together with its white flowers, serve to attract night-flying moths. Honey is secreted by the lower fleshy part of the ovary. In some of the flowers the ovary does not mature, in other flowers the stamens do not ripen, hence the flowers are dependent upon insects for carrying the pollen from flower to flower to secure fertilisation.

A very near relative of this plant is the

Red Campion (*Lychnis diurna, Sibth.*),

also called Bachelors' Buttons, Robin in the Hedge, and many other names.

Some flowers of this species produce perfect stamens only, others produce perfect pistils only, and some flowers perfect both their stamens and pistil. It is stated that the female plants or those which perfect their pistils only, are much more luxuriant than the anther-bearing plants, the females requiring a greater reserve of material than the male plants, in order to mature their seed.



The first five stamens dehisce whilst in the entrance of the flower, their pollen-covered sides being turned towards one another. The insect cannot fail to dust its proboscis with pollen in passing it down the tube of the calyx in search of nectar. When the first stamens wither, the five inner stamens grow up, then the styles reach the entrance to the flower and make one or two spiral turns so that the insect cannot fail to touch some part of the stigmatic surface with its proboscis, already covered with pollen from other plants.

Insects of the genus Dianthæceae and some species of Memestra lay their eggs in the ovaries of this plant, and as the larvæ from the eggs do not destroy all the seeds, the mischief done is probably counterbalanced by the good they do in causing cross fertilisation.

The Viscid Campion (*Lychnis viscaria, Lin.*)

is noteworthy for the abundance of viscid secretion upon the stems. Kerner counted 64 insects sticking to a single inflorescence of this plant.

Kerner noticed that the tendency in plants exposed to the strong light on mountain heights to produce colouring matter (*anthocyanine*) in the cells of their foliage leaves and sepals is particularly apparent in this plant, which became purplish red in colour in his mountain garden.

The Corn Cockle (*Lychnis Githago, Scop.*)

also called Corn Pink, Rough Robin, Meadow Pink, Fair Maid of France, and by many other names. The name Cokyl was used by old writers in the sense of a weed only, but in later years has been appropriated by this plant. Shakespeare says:

Allons! Allons! sowed Cockle, reap'd no corn *

And Spenser says:

And thus of all my harvest hope I have
Nought reaped but a weedie crop of care,
Which, when I thought have thresh't in swelling sheave,
Cockle for corn, and chaff for barley bare.

Some of the stamens of this plant mature before the stigmas, and serve for fertilising the stigmas of other plants by the agency of insects. Others mature later and come into direct contact with the stigmas, securing self-fertilisation in case cross-fertilisation has failed. The seeds of this plant contain 6.5 per cent. of saponine;† this, fortunately, does not render the flour made from corn containing the seeds of this plant poisonous, for saponine is destroyed by the heat in subsequent cooking operations.

We must pass to the chickweed sub-order of this family, most of the plants of which sub-order are inconspicuous, a few only of the starworts being prominent wayside plants.

The Great Starwort or Stitchwort (*Stellaria Holostea, Lin.*),

which has also been called Snap Crackers and some thirty-eight other names, is, perhaps, the most familiar wild plant of this sub-order. It is this plant which, in early summer, spangles the roadside grass and hedges thickly with its white starlike flowers.

* Love's Labour Lost.—III, 3, 353.

† See Soapwort.

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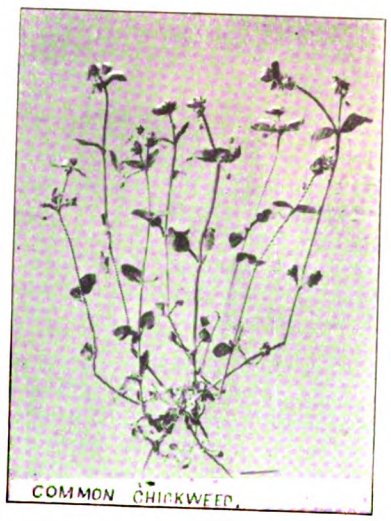
The flowers have ten stamens, those opposite to the sepals become mature before the stigmas of the same flowers are capable of receiving pollen, their pollen, therefore, only serves for cross- fertilisation, and their anthers often drop off when they have discharged their pollen. The anthers of the stamens opposite the petals dehisce next, these ultimately come into contact with the stigmas, causing self-fertilisation if cross-fertilisation has not already taken place. It is noteworthy that this, which is the most conspicuous of the chickweed sub-order of the Pink Family, has its flowers constructed to secure the aid of insects for cross-fertilisation, whilst other less conspicuous members of this sub-order rely mainly upon self-fertilisation.

The Water Starwort (*Stellaria aquatica, Scop.*) is the next most conspicuous plant of this sub-order. Its fertilisation is accomplished in a similar manner to that described under the last species, but self-fertilisation is more frequent in this case.

Remains of this plant have been found in pre-glacial and inter-glacial deposits in Great Britain.

The Common Chickweed (*Stellaria media, Cyrill*) is, perhaps, more typical of plants of this sub-order than the above two,and it is possibly the most common of our garden weeds. Sir Joseph Hooker tells us that on one occasion, landing on a small uninhabited island near the antipodes, the first evidence he met with of man having set foot there was some English Chickweed. This he traced to the mound which marked the grave of an English sailor and which was covered by this plant, doubtless the offspring of some seed carried by the spade or mattock with which the grave was dug.

The rapidity with which this plant spreads has been attributed to its system of self-irrigation. A cup is formed by the base of each pair of leaflets, in which rain or dew collects, and into which patches of earth are washed. The frill of hairs on the margin of



COMMON CHICKWEED.

the leaves helps to hold the moisture, and the line of hairs down the stems conveys the overflow of moisture from one leafcup to another. From many of the leaf axils of this little plant one or two small rootlets appear, and it is suggested that the little leaf-cups promote the formation of these rootlets, and that the water would also serve to moisten the earth just where the rootlets enter the ground.

The flowers are inconspicuous, but probably secure insect visits in the early spring before the more luxuriant flowering plants compete with them. It is very abundant in our hedges in very early spring, but soon becomes choked by more vigorous vegetation. As a garden weed it holds its own throughout the year, in fact, it continues to flower almost all the year round. This plant, in fact, holds its own by its power of spreading rapidly by means of its little rootlets, and by the fact that it flowers at almost all seasons of the year, and by its capacity for holding its own under conditions of cultivation.

The Mouse Ear Chickweed (*Cerastium vulgatum, Lin.*) is also a very common, inconspicuous, and humble plant, which mostly produces seeds from self-fertilised flowers, though cross-fertilisation is also accomplished by the agency of small insects. It flowers the whole season, and occurs in cultivated and waste places, pastures and woods, wet or dry nearly over the whole world. Its many variations are a great puzzle to botanists. It succeeds in holding its own under conditions which few plants could survive.

This sub-order includes also the Sandworts (Arenaria species), the Corn Spurry, Sand Spurry or Pearlwort (*Spergularia rubra*), and the Sea Pearlwort (*Spergularia salina*). Some authors consider the Sand Spurry or Pearlwort and the Sea Pearlwort as mere varieties of one species; if this is so, it is noteworthy that whilst the inland form is constant in its characters, the Sea Sand Spurry has several variations. May we conclude from this that the latter is the more recent form, and, therefore, the more readily varies to adapt itself to fresh conditions?

Theory of Solar Protuberance.

AN interesting attempt to explain the nature of solar protuberances by anomalous dispersion is offered in a paper by Professor W. H. Julius, read before the Dutch Academy of Sciences. In former papers the author had suggested the following hypothesis as to the constitution of the portion of the solar atmosphere outside of the so-called photosphere; the various elements, the presence of which in the atmosphere of the sun has been inferred from spectral analysis, are much more widespread than had formerly been assumed on the nature of luminous phenomena. They may occur even over great distances beyond the photosphere, and still be visible only at some places, their own radiation contributing very little towards rendering them visible; the distance beyond the disc of the sun at which the characteristic light of the substance is seen is mainly determined by local variation in their density, in connection with their property of giving rise to anomalous dispersion. No hypothesis as to the origin of the chromospheric light had been made, as nothing had been said about the interior of the photosphere. In order to continue these considerations, the author makes use of the three propositions in which Mr. Schmidt sums up the principal points of his theory, according to which the surface of the photosphere, so far from being the limit of a body, would constitute only a sort of *critical sphere*, defined by the property that its radius is equal to the radius of curvature of the horizontal light rays passing through points of its surface. On this theory, not only the edge of the photosphere, but even the protuberances, would be formed by regular reflection. Now in order to account for the fact that the light from the protuberance and chromosphere is not white, but shows a line spectrum of variable aspects, Schmidt considers the strongly radiating part to be constituted so that the exterior part would emit almost exclusively the light of hydrogen, calcium, and helium, whereas the sodium, magnesium, titanium, and iron radiations would come from the inner layers. By the use of the principle of anomalous dispersion it is, however, possible to assume that the mixture of various substances is present throughout the gaseous mass, inside as well as outside of the critical sphere. Wherever streams, vortices, &c., give rise to differences in the density of the gaseous mixture, the conditions for an irregular curvature of the rays are given, it being evident that out of the substances present in the mixture those possessing very strong specific dispersion for certain kinds of the transmitted light will be detected over particularly wide distances beyond the solar disc, whereas others, though equally present, will remain invisible. The fact that the various gases of the sun appear to be separated, though no real separation need be presumed, is thus accounted for in a purely optical way. This latter hypothesis, the author shows, is a necessary consequence of the representation of the sun as a gaseous rotating mass giving off heat, as a continuous intermixing of the elements such a body is made up of must of necessity take place. The external layer of the gaseous mass, being most rapidly cooled by radiation, will gradually drop and be replaced by rising gases, being warmer, so that, but for the rotation of the sun, only radial currents would be met with. On account of the rotation about the axis these currents, however, are considerably modified, the angular velocity of the descending masses increasing, whereas that of the rising masses will be diminished; gaseous layers of different densities rotating at different speeds are thus obtained beside one another, being susceptible of a relative motion for some time without their becoming intermixed. Owing, however, to the friction, this surface gradually takes the form of a wave surface, the wave being propagated along with the layer, the velocity of which is highest, so as to form by the mixture of two neighbouring surfaces a new layer with intermediate properties. Inside of each layer, as temporarily included between two surfaces of discontinuity, convexion currents will continuously convey cool substances downwards, warm matter rising at the same time, so as to re-establish continuously the difference in speed. The author now contends that the whole of the chromosphere with all its protuberances is constituted by this system of waves and vortices, made visible up to distances more or less great beyond the edge of the sun in virtue of the anomalous dispersion of the photospheric light. The chromosphere, in this theory, is ascribed to the relatively small vortices, the continuous winding-up of the surfaces of discontinuity, whereas the protuberances are regarded as the vortices the very great waves of the solar sea are transformed into. Many apparent contradictions afforded by the enormous velocity of propagation of solar protuberances may thus easily be done away with. In fact, the term velocity may be applied only to a displacement of matter or to the propagation of a chemical phenomenon, or, finally, of a state of movement. Nothing of the kind, however, is met with in the present case, as the formation of vortices takes place only under the influence of the local state of the matter, and is not due directly to a similar motion pre-existing at other places. The phenomena in question are comparable to the propagation of the waves of the sea, where also there is no velocity proper.

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The Limits of Microscopic Vision.

By G. H. BRYAN, Sc.D., F.R.S.

Part III.—Resolution of Isolated Pairs of Objects

SOME time ago, Dr. Johnstone Stoney showed from theoretical considerations (1), that a *single pair* of objects should be theoretically separable under the microscope, even when their distance apart was somewhat less than the limit of distance between a row of equidistant markings consistent with visibility, and (2), that under such circumstances the two objects would appear slightly further apart than they really are.

These conclusions, which were verified in connection with the resolution of double stars by means of the telescope, have been readily confirmed by Dr. Stoney by means of the Grayson rulings.

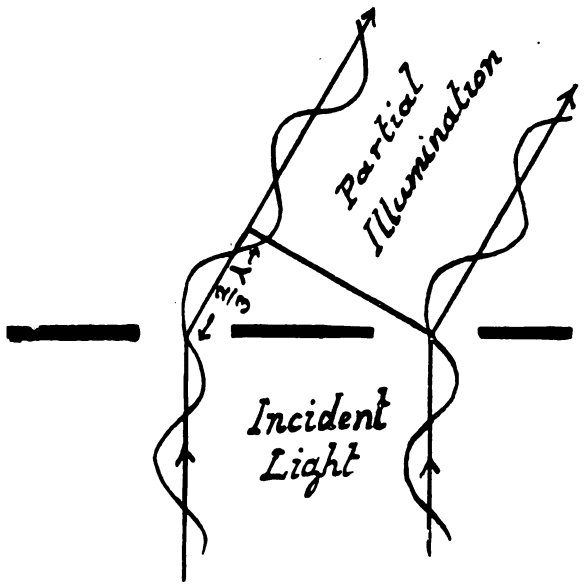

Fig. 17.—Light coming through two apertures with a difference of path of two-thirds of a wave length will not produce darkness.
If there were a third aperture as in Fig. 13 the waves from this would neutralise those resulting from the two apertures.

Dr. Stoney's slide of these rulings contains in one of the bands a pair of lines which project beyond the rest. By gradually stopping down the aperture of the objective with a diaphragm, Dr. Stoney shows that the projecting parts of these lines are still visible as two distinct lines, even after the remaining rulings are obliterated, but that their distance apart appears greater than was that of the rulings.

These results find their explanation in the difference which exists between the diffraction phenomena presented by a grating and those presented by a pair of objects or apertures.

If we take a screen containing only *two* openings, the waves flowing through and radiating from these openings will only interfere in such a way as to produce total darkness when there is a "difference of path" of exactly $\frac{1}{2}$, $1\frac{1}{2}$, $2\frac{1}{2}$, ... wave-lengths. A single pair of waves cannot neutralise each other completely for any other relative position (compare, *e.g.*, Fig. 17). The maximum intensities in the diffracted beams will, as before, correspond to "differences of path" of exactly 1, 2, ... wave-lengths, but between these maxima the brightness will gradually shade off towards the directions of total extinction. The transmitted and diffracted light,

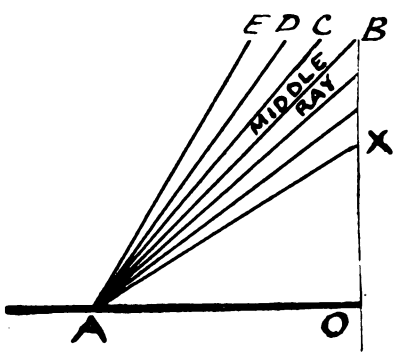

Fig. 18.

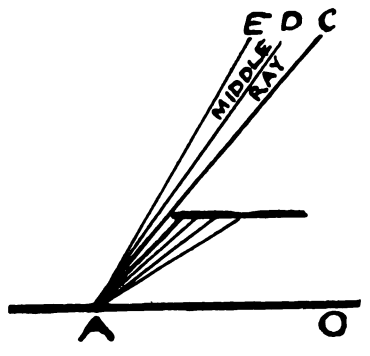

Fig. 19.

By cutting off the lower rays of a diffracted pencil the elevation of the middle ray is increased. A B is the middle ray in Fig. 18, and A D is the middle ray in Fig. 19.

instead of being confined to particular directions, will be distributed over pencils or fringes, one of which will begin where the previous one ends.

It is, therefore, possible to bring a *portion* of the first diffracted pencil into the aperature of the object without bringing in the central ray. The necessary "difference of path" may, therefore, be less than one wave-length. Even this part of the diffracted pencil is sufficient to render the two apertures visible as separate objects.

Another effect of cutting off the lower rays of the diffracted pencil is to increase the average angle at which the rays received leave the plane of the lamina. The meaning of this statement may be understood from Figs. (18), (19). When the whole pencil X.A.E. is transmitted we may suppose A.B. to be the middle ray and O.A.B. to be the mean angle at which the pencil comes off. When the transmitted portion is cut down to C.A.E., the middle ray is necessarily higher, say A.D., and the angle at which this ray leaves the screen correspondingly greater. *The effect of this is to make the diffracted pencil approach more nearly in character to that which would be produced by a pair of apertures at a somewhat greater distance apart.*

It would be an easy step to conclude by saying, "Therefore, the objects will appear further apart than they really are, Q.E.D." Unfortunately, this argument *cannot* be considered legitimate, even although the conclusion is correct. It does not appear possible to explain the phenomena adequately in a simple manner, and the above rough and ready argument should, therefore, be accepted for what it is worth.

To apply these arguments to a pair of objects in a transparent medium it is necessary to establish a well-known proposition connecting the diffraction effects produced by one or more opaque obstacles with those which would be produced by openings in a screen occupying the spaces (which we will call S., T.) previously filled by the obstacles. When both the screen and the obstacles are absent the light waves pass straight on without diffraction taking place. Hence, the diffraction effects produced by the light waves falling *outside* S., T. must exactly neutralise those produced by the waves falling *within* S., T. Therefore, the diffracted waves produced by the obstacles must be

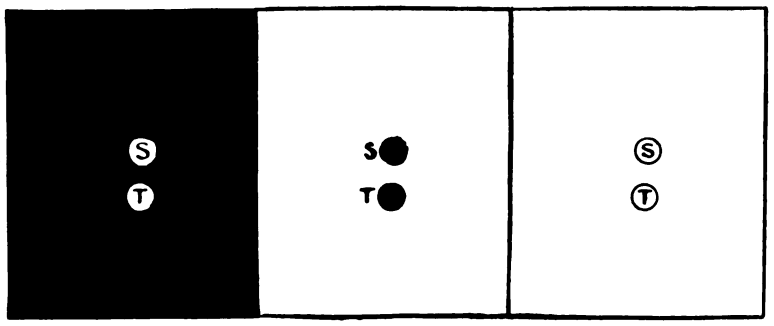

Fig. 20. Fig. 21. Fig. 22.

The diffracted rays produced by the openings S T — **balance** — **the diffracted rays produced by the obstacles S T,** — **because** — **if light passes both through and outside the circles S T we have a uniform beam without diffraction.**

related to those produced by the openings in the same way as a pair of waves which interfere in the manner explained in Part II. The intensity of the diffracted light sent out in any direction from the obstacles is, therefore, the same as that sent out from the apertures in the same direction, the only difference being that the crests of the waves in one case correspond to the troughs in the other; in other words, there is a difference of half a wave-length between the positions of corresponding waves at any instant.

Summary:—We have thus shown that:—

(1) There is no limit to the smallness of an object which may be detected under the microscope, provided that it is sufficiently distant from neighbouring objects.

(2) It is impossible to resolve a series of equidistant objects unless their distance apart exceeds half a wave-length of light.

(3) A pair of objects can be separated, when their distance apart is rather smaller than the limit required for a number of objects in a row; but in this case the objects are not seen at their true distance apart.

The only way that suggests itself of extending the limits of microscopic vision is by reducing the wave-length of the light.

This may be done by the use of highly refractive media, the wave-length of any kind of light being inversely proportional to the refractive index of the medium through which it is travelling. The use as a mounting medium of realgar (sulphide of arsenic) has greatly facilitated the resolution of test objects. But if the light has to pass through a cover glass of lower refractive index, the diffracted rays may be totally reflected and fail to enter the object—glass, and it is easily deduced that the limit of resolution depends on the wave-lengths of the light in the least refractive media that the light has to traverse (1), from before it has left the last lens of the substage-condenser till it has reached the object; and (2), from after the light has left the object till it has penetrated the first lens of the objective. Hence, further advances in this direction would require the use of more refractive substances for the objective, condenser, slide and cover glass, and for the immersion fluids filling the gaps between them.

The only other direction open to us lies in the use of ultra-violet light, whose wave-length is too short to be visible to the human eye, but which is capable of producing impressions on a photographic plate. In this case only the photographs and not the actual magnified objects will be brought within the range of human vision.

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Application of Photography without Objective.

For Embroidery and Weaving Designs.

THE Société de dessins Industriels recently invented the following process for obtaining weaving patterns by photography. Designs with continuous outlines can be transformed into ones with outlines in echelons or tiers. In fig. 1 A is a screen made on a photographic plate with a great number of transparent dots B, at regular intervals on an opaque ground.

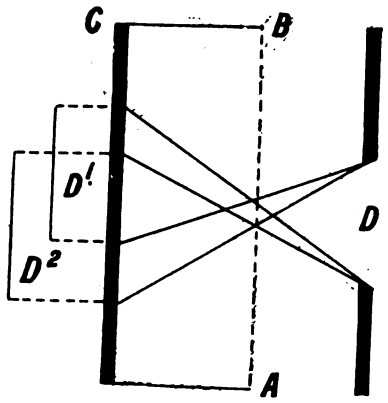

Fig. 1.

Behind this screen on the side opposite the holes B there is a piece of tracing paper C. Then if in front of the screen there is a square window D, uniformly lighted, each of the transparent points B acts as a stenopaic opening, and gives an image D_1 D_2 of window D. A given distance separating window D from screen A, two consecutive holes give images D_1 D_2, encroaching on each other (fig. 1). If in such circumstances a transparent film, bearing the design to be transformed, is placed against holes B, this design will mask a certain number of holes B. The various images of window D given on the tracing paper C by the holes B will produce a design similar to that on the film, and the outlines will be bounded by a succession of images from window D. But as two consecutive images from this window encroach on each other the outlines of the design will be indistinct. To obtain clear outlines the window D must be square or rectangular, and its distance from screen A fixed so that

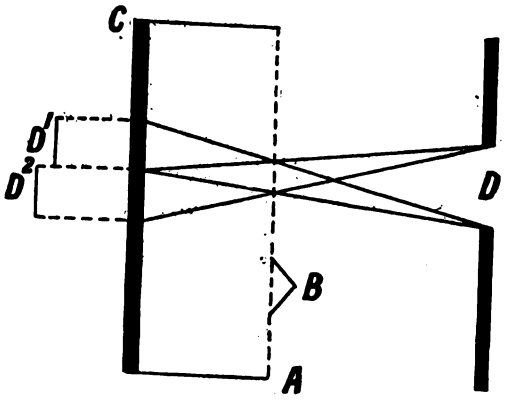

Fig. 2.

two consecutive images D_1 D_2 are contiguous and separate (fig. 2). When such is the case, the images formed by the different holes B are completely separated and the line of holes following the outlines of the original design reproduces the latter on the tracing paper C, with outlines of contiguous very distinct squares, *i.e.*, outlines in echelons. It is essential to have the window uniformly lighted whatever the incidence under which it is seen. Practically window D is a square opening perforated in a thin partition. The design and screen are placed in a frame opposite this opening, and the frame is moved until one sees the images of the window unite. Then the tracing paper C is replaced by a sensitized plate upon which a negative of the design in echelons is obtained after suitable exposure and development. It suffices to print from the negative in the desired scale.

In the case of embroidery, enlargement is operated on checkered paper previously sensitized. To make a design for textiles work is as follows:—

The design is obtained on a negative by successive prints of the weaving it contains. But there are no echelon outlines. Merely all the inner weaving is indicated, care being taken, however, to have the negative exactly on the scale of the screen with transparent points, so that it can be superposed.

Then the design negative is placed on the dotted screen negative, gelatine against gelatine. The opaque dots previously printed on the design negative mask the corresponding points on the screen with transparent dots. If then both negatives are put into the printing frame, as explained above, and uniformly lighted by aid of diffused light a negative image of the design is obtained on a sensitive plate placed behind the screen-negative, because each opaque point of this design masks the corresponding transparent point of the negative with small dots, and besides outlines or reserves (flower stalks, ribs of leaves, &c.), are obtained in echelons as previously explained. The design negative with echelons is then projected on paper previously checkered and sensitized. Thus designs can be made for weaving on the Jacquard loom.—*Cosmos*, Oct. 31, 1903.

The Palm of the Hand.

IN a recent paper on the human hand, Mr. E. J. Evatt remarks: "During the course of development of the hand eleven well-defined pads or cushions appear on the palm. The earliest disposition and form of the pads correspond very closely with that which obtains in certain lower animals (*e.g.*, mouse), and the pads in both cases are probably morphologically equivalent, and, further, in man's remote ancestors possibly served similar functions. In the adult the pads may be regarded as vestigial. It is probable that when the hand began to be used as an organ of prehension, rather than of locomotion, the deep layer of the epidermis invaded the corium in a fluted form, and in this way the close and complicated papillæ were differentiated. The interlocking of the corium with the epidermis serves probably to strengthen the connection between the two. The interlocking ridges or deep flutings are at first comparatively simple in their arrangement, and tend to lie transversely to the long axis of the limb, even on the sites of the original pads where the patterns eventually assume most complex forms. Later on, yet long before the ridges appear on the surface, the deep flutings have assumed the patterns characteristic of the adult papillary ridges. The papillary patterns appear on the surface at about the eighteenth week, and are formed by the intervening epidermal tissue sinking in between the buttress-like processes of the underlying flutings, and they thus come to be the counterpart of the perfected patterns upon which they are moulded. The convexities of the patterns on the pads of the fingers are directed distally, while the convexities of the patterns over the remaining pads take a proximal direction; that is, in grasping, the convexities are directed in lines of least resistance; it would, therefore, seem probable that as the hand became an organ of prehension the flutings assumed the forms already described as the result of mechanical forces.

Roman Oculists' Seals.

A ROMAN oculist's seal has been found at Rugles in the French department of the Eure, and is now in the possession of the Court of the Intendant-Général of Chalons, to which a special interest attaches from the fact of its having upon it the name of a new collyrium. An unusual feature is the omission of the seal-owner's name which has not been engraved. Possibly engravers kept a stock of seals, enumerating the most fashionable oculist remedies, or again, in the case of those seals that are inscribed with a name, it may merely be that of the oculist famed for the invention or application of the collyria enumerated upon it, and not that of the owner. The inscription of the Rugles seal is as follows:—

1. Collyrium fo's post impet(um).
2. Diapsoricum delacrimator (ium).
3. Diceutetum post impetum.
4. Dieloeum leu(c) ad siccaru lipp (itudinem).
1. Collyrium light (to apply) after the acute period of ophthalmia. 2. Collyrium diapsoricum to excite (or staunch) tears. 3. Collyrium diceutetum (to apply) after the acute period of ophthalmia. 4. Collyrium of sweet oil to counteract dry ophthalmia. In the Paris Bibliothèque Nationale is a small lead vase, the inscription upon which Phos (φως light) suggests that it must have been intended as a receptacle for this ointment. The Roman oculists affected such titles for their remedies. Other names for Collyria are Theodotium (gift of the gods), Aliemetum (inimitable), or Basilicum (royal). It is a curious and interesting point that Alexander of Tralles in "De Re Medica," mentions "φως" as a remedy for feeble vision. He gives the ingredients as: "Oxide of zinc, drachmæ 8; sal ammoniæ, dr. 4; saffron, dr. 2; white pepper, dr. 3; nard and orpiment singulorum, dr. 1 et S. valde bonum." He adds "Pulvis cui nomen est a lumine φως ad habitudinem oculorum efficax." Where upon a previously published seal the word "foos" occurs, it was, we were told, to be applied "ad lippitudinem," that is to the cure of incipient ophthalmia, and, therefore, in both cases it claimed to be a remedy for the same malady, though "post impetum" refers rather to the period when the ophthalmic attack becomes less acute, and when, the inflammatory pain subsiding, the disease threatens to become chronic.

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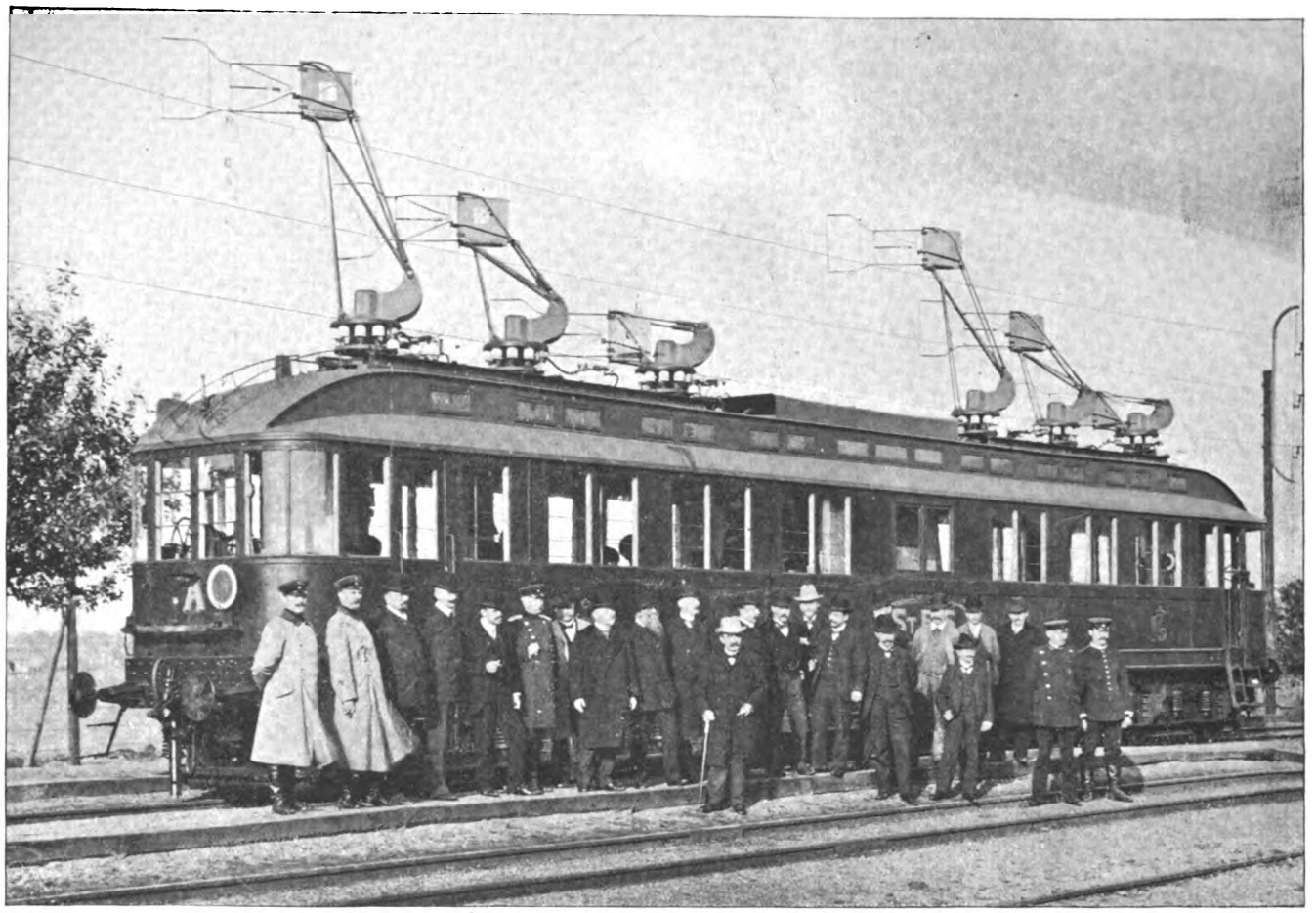
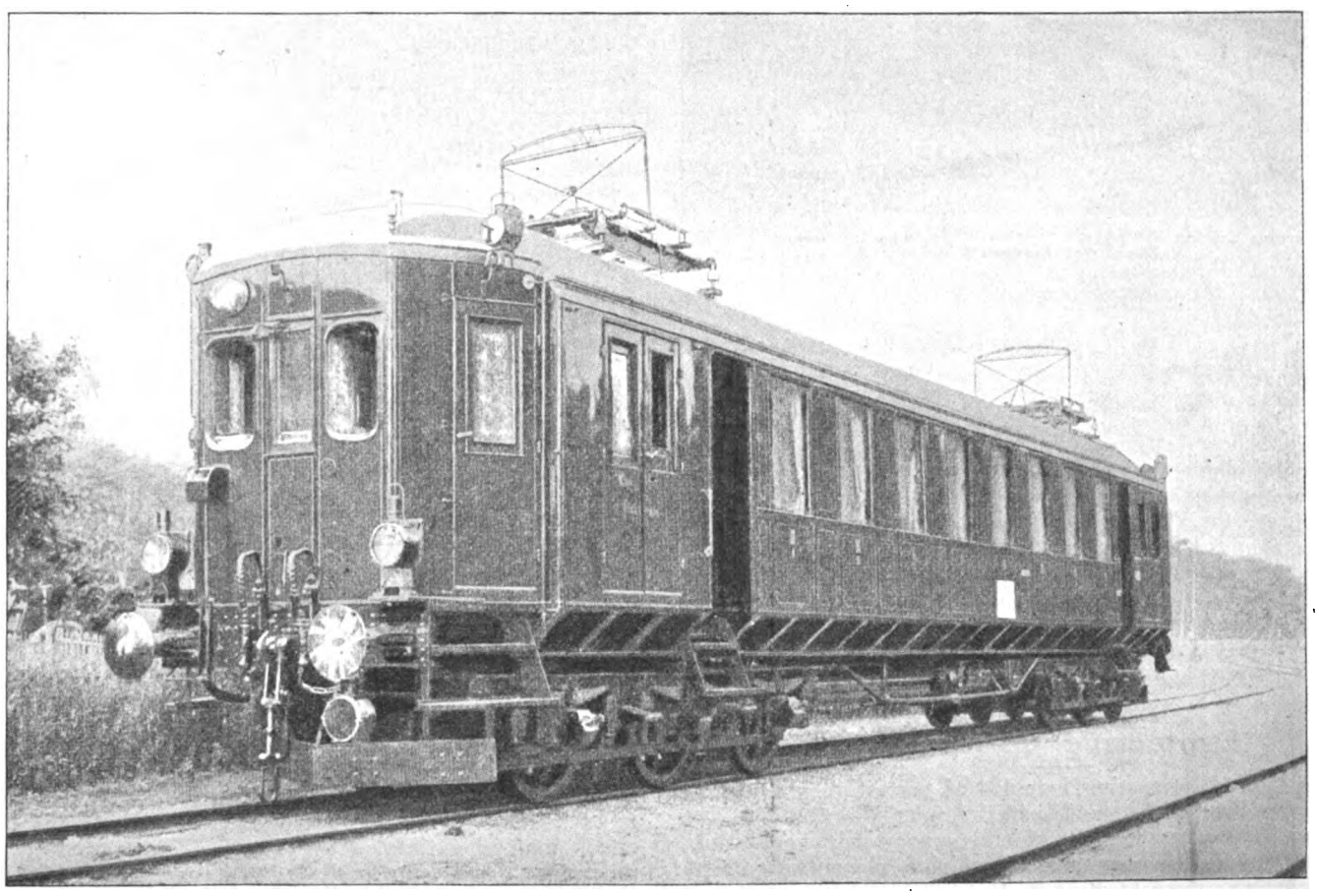
Alternating Current Electric Railways.

SIMULTANEOUSLY, with the Marienfelde-Zossen high-speed trials, electric traction experiments are being made in another direction by the Union-Elektricitats-Ges on the Spindlersfelde-Johannisthal line, near Berlin. Though arousing less sensation than the former, these trials are likely to have a more immediate bearing on the development of electric traction. In fact, it is not intended there to attain any unusual speeds, but rather to investigate the conditions of a regular electric traction service on railways in their present form, and even on small gauge railways. Single motor cars are being run at present, which, however, are to be replaced later on by trains made up of two motor cars and several trailers; these cars, including the whole of their equipment, have a weight of 52 tons, the electric equipment corresponding with six tons. There are two 152-h.p. motors mounted both on the same truck, and there is, in addition, one exciting system, and at either end one controlling roller. Any desired number of such cars may be coupled together and controlled from one motor-man's stand. The current is collected through two short bows; and there are, in addition to fuses, automatical safeguards against excessively high currents. A small transformer supplies the current for the air-pumps as well as the steering and lighting currents; there are no shunt resistances.





The motors are designed, according to Winter and Eichberg's

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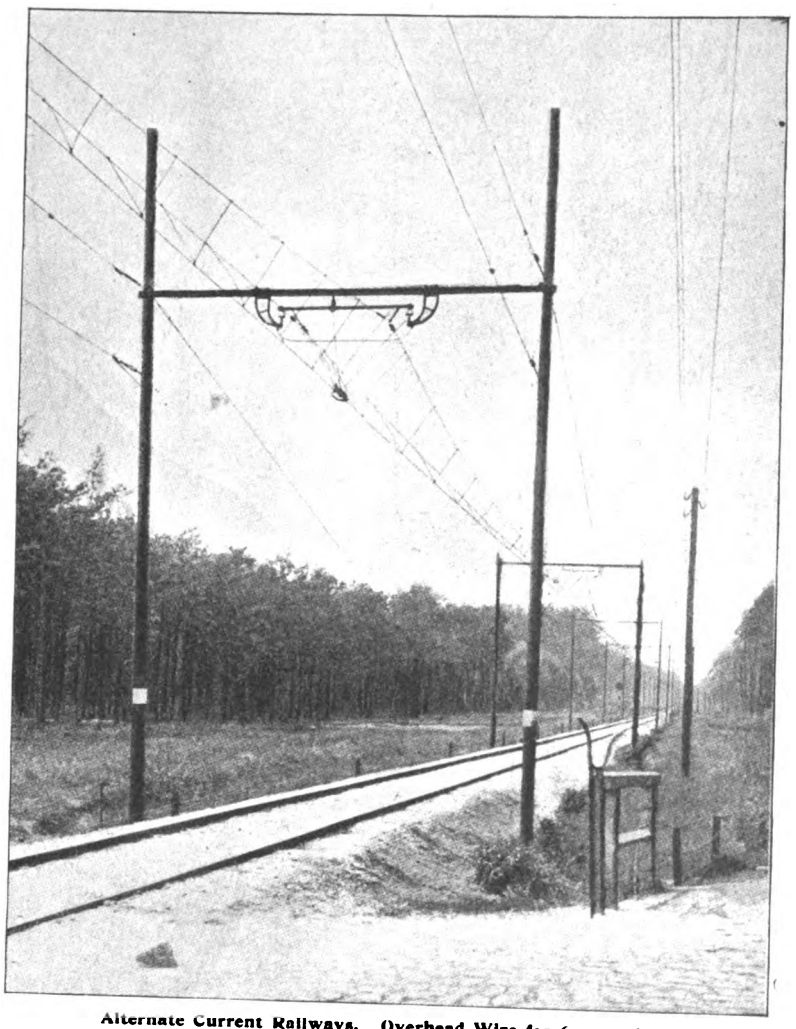
data, for a tension of 6,000 volts and 25 periods. They are permanently connected in parallel, and though their efficiency at full speed is, of course, somewhat lower than the efficiency of direct-current motors, the advantage of the latter is compensated by their great energy oscillations in starting. The overhead wire conveys to the carriage the electric energy at the tension of 6,000 volts, the running rails serving as return. A remarkable feature is the suspension of the working wire, effected instead of by transversal wires, by means of longitudinal wires stretched like fairly loose catenarian curves. Thin wires, suspended from these longitudinal wires at distances apart of about 3 m, support the working wire. Part of the track is fitted with one and part with two bearing wires; experiment will show which is the better design. This arrangement of the wire, where the working wire has nearly no tension, will materially diminish the danger of a rupture of the latter, and as the end of a broken wire is beyond the reach of the



Alternate Current Railways. Overhead Wire for 6,000 volts. Johannisthal—Spindlersfeld.

railway personal, the consequences of a fracture are at the same time diminished.

Whereas both with the Lamme and Dr. Finzi motors, being series motors, the energy has previously to be reduced to low tension by means of a transformer, the Union motor will immediately absorb any desired tension. This results in the weight of the car being lowered and the efficiency improved, the former factor being important especially in the case of small gauge railway. A further difference is the fact that the Union motor is designed for 40 periods, whereas the Westinghouse motor uses 16 2-3 and the Dr. Finzi motor 18 periods. The fact, however, that alternating current railways designed according to the Union system may immediately be fed from machines designed for lighting purposes, is likely to be of special importance, justifying the electrification of railways even in cases where it would not pay to instal special machines or power plants.

Protective Mimicry.

A REMARKABLE and interesting instance of protective mimicry in fishes is to be observed in the Marbled Angler of Saragasso Sea (*Pterophryne Histrio*). This fish, which is a poor swimmer, has its chief haunts among the coral weeds, which it closely resembles. Curiously enough, it constructs a nest of weeds, which is held together by threads, and is about the size of two closed fists. This nest it fills with eggs, scattered through its mass. The coral weeds are a singularly safe asylum for it, for not only does it resemble them in form and colour, having cutaneous filaments about its body and fins, and a colouring of pale yellow with dark brown bands, but it is, besides, covered with small white specks in mimicry of the minute shells (spiralis) with which the Saragasso weed is frequently covered.

On the So-Called Distance Effects.

EVEN if the attempts of previous generations to explain distance effects as the effects of gravitation had been more lucky, the law of gravitation, as pointed out by Prof. A. Korn, in the *Naturwissenschaftliche Wochenschrift*, would be rather inconvenient as a fundamental hypothesis of physical science, a continuous propagation of the effect of gravitation through an intermediate medium being incapable of satisfying the ideas of continuity to which modern physics has gradually led us. Considerations which allow for the hypothesis of an intermediate medium and presume in the latter a gravitation energy, giving rise to the effect of gravitation, will stop half way, as they fail to explain this gravitation energy as mechanical energy. A real philosophical advance cannot be obtained, unless such a mechanical interpretation be adopted, comprising a large and important class of natural phenomena within the simple laws of mechanics. Apart from a number of mechanical conceptions, giving evidence of fancy rather than of scientific spirit, there are only two theories possible, viz., the corpuscular and vibration theories.

The former is based on the conceptions enunciated as far back as the 18th century by Le Sage, presuming the intermediate medium to be made up of an extraordinarily great number of particles, performing movements apparently devoid of order. In order to facilitate the explanation of gravitation on this hypothesis, let two celestial bodies such as, *e.g.*, the Sun and the Earth be given, systems of small particles travelling from all sides towards these two centres. In this case it is evident that an attraction will occur, the opposite sides of the two celestial bodies being exposed to the shocks of a greater number of particles than the sides in front of one another, this being due to a mutual screen effect. Now, supposing the intermediate medium, in accord with the kinetical theory of gases, to be made up of particles, the motion of which is devoid of order, how could such a stream of particles towards the two centres be produced? Evidently, some particles of this intermediate medium would unceasingly undergo the shock of the two celestial bodies, and, if these bodies be perfectly elastic, would be repelled with the same speed at which the shock has occurred. It will easily be understood that in this case a seeming equilibrium would be maintained, the intermediate medium behaving like a gas at the state of apparent equilibrium. As regards a stream towards the two centres, this evidently would be quite out of the question. Different phenomena will be observed if the shocks are not perfectly elastic, *i.e.*, if the particles striking the celestial bodies give out part of their *fors viva* at the state of heat. In this case a perpetual stream towards the two centres, and hence in accord with what has been said, an attraction between the two celestial bodies would of necessity take place.

The vibratory theory is based on a fundamental experiment by Professor C. A. Bjerknes, imparting to two caoutchouc spheres immersed in a liquid such as water, so-called *pulsation* movements, *i.e.*, vibrations altering the volume, and in virtue of which the spheres in a periodical succession are expanded and contracted, the two spheres will attract one another if the *phases* of the pulsations are identical, *i.e.*, if the two spheres are simultaneously contracted and expanded. Prof. Bjerknes has made this experiment by leading periodically air to the spheres through small tubes and driving it out from them again. In a somewhat inversed manner the same results may be obtained by placing within a great copper sphere filled with water a fixed and a movable caoutchouc sphere and producing synchronous pulsations by means of a periodical supply and derivation of water through tubes symmetrically arranged at the surface of the copper sphere. In the case of sufficiently rapid pulsations, a very strong attraction will take place between the copper spheres, it being possible to reduce the amplitudes of the vibration, so as to render the vibrations scarcely appreciable to the eye.

According to the vibratory theory of gravitation, heavy particles would perform analogous pulsations of an exceedingly small amplitude, while the intermediate medium moves like a liquid, *i.e.*, behaves at least for very rapid vibrations in the same way as a continuous and incompressible medium, this being for mathematical analysis the most simple of conceptions. In accord with Newton's gravitation law, an attraction between two particles is thus obtained, by giving the radii of the particle very small values as compared with their mutual distances.

But why are these particles performing similar pulsation movements? How may the fact be explained that all the particles should have the same period and the same phase of pulsation? This explication may be facilitated by means of an example derived from acoustics. Let a volume filled with a compressible medium such as, for instance, a covered pipe susceptible of an infinitely great number of sounds and proper vibrations be given: the vibration with minimum frequency will be the fundamental sound, the first upper harmonic being the vibration coming next, and so on. Any system made up of either incompressible or compressible media, arranged in any way, will equally be susceptible of an indefinite number of proper vibrations like our system made up of the continuous and incompressible medium filling the intermediate space, and of material particles to which a certain compressibility is ascribed. The *funda-*

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mental vibration will be the pulsatory vibration of the corpuscles producing gravitation, their attraction being in accord with Newton's law, one of the most common and most important distance effects being thus reduced to purely mechanical fundamental conditions.

The general problem of the proper vibrations of our system constitutes a question susceptible of mathematically accurate formulation, the formal difficulties increasing, however, in a noticeable way as the harmonics are examined. Carrying out this investigation for the case of the first harmonic, and calculating the apparent distance effects as produced by two particles, or rather two systems of material particles in virtue of this first harmonic, a repulsion is obtained varying inversely as the fifth power of the distance. To this result, an important physical significance could be ascribed. As long as the distance of two parts remains above a certain amount an effect of gravitation only will be noted, whereas for a greater vicinity the repulsion would be the stronger, in virtue of the first harmonic; the particles will be repelled as though they had exerted a shock on one another, a mechanical interpretation of Maxwell's gas theory being thus formed, in virtue of which the particles of a gas would exert on one another a repulsive action as soon as their distance apart decreases below a given value. The whole of the theory of gas friction, as well as the principles of thermodynamics, thus receive a purely mechanical interpretation.

Continuing these researches, and examining the upper harmonics, there will, in virtue of the latter, be obtained apparent distance forces between the material particles, being inversely proportional to a power of the distance, the greater as the harmonic considered is higher. As a consequence of the second harmonic, an attraction will also be obtained, this fact having a great physical importance; as the two gaseous particles approach towards one another, attractive forces, *i.e.*, the *capillary forces*, will add themselves to the forces of repulsion, the continuous passage towards the liquid state, as established by Prof. van der Waals, thus being obtained. According to these results, we should expect elastical forces, as well as effects of chemical affinity, in turn, to be explained as similar seeming distance effects, in virtue of the upper harmonics of our system, the electrical and magnetical distance forces being equally included within these theories.

A. G.

Weather Forecasts and the Barometer.

SINCE the invention of the barometer by Torricelli, this instrument has been utilised as a weather indicator. High pressures signify settled, fine weather; average pressures and variable low pressures, wind or rain. These variations were at first ascribed merely to the greater or less degree of humidity or siccity of the atmosphere. However, such an explanation is evidently incomplete, and we have demonstrated that the cause is, and can only be, in the conditions of rest or perturbation of the atmospheric currents by which the instrument is affected. In the state of rest, or at least in the circumstances which most nearly approach it, occur the heaviest pressures; with movements of average velocity, pressures are already considerably decreased; and bad weather is accompanied by more or less marked pressures, according to the greater or less vortiginous disturbances. Thus, the air, which always moves horizontally, weighs less according to its greater velocity. Now it is upon these motions of the atmosphere that disturbances depend, and the corresponding pressures exactly reveal them. Perturbations due to aërial agitations often originate at a considerable altitude in the atmosphere, and the barometer records what could not be anticipated. While the weather is yet apparently settled, a depression is indicated, for there is already motion above the lowest strata. Similarly the weather is bad and yet pressure is diminished; the current which is the seat of action has already moved to a distance, and there is only disturbance below. As for the medium part of the said disturbance, it is affected in proportion as the whole of the currents co-operated in the action. Though the barometer accurately indicates the condition of the atmosphere, it can give us no information respecting the origin of the variations. We know now that the atmosphere is intersected by currents, some of which start at the equator for the poles, while others descend from the polar regions to the equator. This is the source of all atmospheric disturbances. These currents, always in contact, mutually act upon each other and engender the perturbations.

Influence of the Moon.

The moon has been, and is still, brought into the question, though nothing hitherto met with in observations has proved that the moon, with the co-operation of the sun, really exerts any influence on weather. Effects produced at very variable distances have been ascribed to its intervention, and it is chiefly owing to these diversities that there is reason to think, irrespective of any other consideration, that the moon has nothing to do with weather changes. But there are other means to convince ourselves of this. In its transit the moon raises water from the ocean, and must also attract the atmospheric strata. It does so, however, in circumstances which prove its inaction as regards meteorological variations. The tides out in the oceans, where attractions are perfectly free, are an average of 1 metre in altitude, a little more or a little less, according to epochs and phases. A column of water 1 square centimetre in area and 1 metre high weighs 100 grammes. Consequently it is 100 grammes without reckoning the slight difference due to density, which the moon with the sun attracts to it on this area of 1 square centimetre, and we must conclude it is a similar weight of air that is displaced. Now it has been calculated that a column of air rising from the ground to the extremities of the atmosphere, and of the same diameter, viz., 1 square centimetre, weighs 1·033 kilogramme. Thus the moon only raises one-tenth, and one is very far away from the lower strata, where meteorologic phenomena are produced. There is, however, a distinction to be made, as the density of the air is far from being the same at the upper and lower limits of the atmosphere. There is a divergency of opinion as regards the height of the atmosphere. The average of the estimates made may be taken as something like 20 leagues. Recent experiments with pilot balloons, however, demonstrate that it is much greater. It has, in fact, been noted that the air is rarefied in the higher regions with much greater rapidity than has been supposed. All the higher parts of the atmosphere might then be perturbed by transit of the moon, whilst the others were left unaffected even by contact. In their case it would be the same as that of the ocean beds when the tides sweep over.

Effect on Barometric Pressures.

It is clear, then, that the moon has not, and could not have, any effect on the variations of weather. But it might none the less have one on barometric pressures; and this is a second aspect of the problem. If attractions do not cause changes in the weather, and thus exert no action on the barometer, the question is evidently not the same when we consider them as they really are. It has been said that their action with regard to the atmosphere would be exerted to the extent of $\frac{1}{16}$ of its weight, and that in these circumstances it might, owing to the very slight density of the higher currents, extend to some considerable depth. The tides raised by the moon would thus attain rather great heights, and, on the other hand, corresponding depressions would be produced. These are the movements which must necessarily be recorded in observations; but not so minutely, perhaps, as one might think. Raised by attractions, neither the strata of air nor the water of the oceans augment in weight. On the contrary, it decreases according to its very greatness. Far from revealing itself on the barometer by greater pressures, the higher atmospheric tides are recorded by lower pressures; and it would be the same with the lower tides, as the masses of air attracted elsewhere would have lost part of their contingent. Only the intermediary spaces would recover their normal weight, and this would always be greater than the others. Thus, when the moon crosses the meridian and the opposite meridian there are falls of the barometer, as also at its two crossings of the horizon; but there are four successive rises in the day during the intervals between high and low tides and *vice versâ*. Consequently, it is to these points especially that attention should be given in observations. Has this been done heretofore? The observations necessitated by the movements of the atmosphere from the point of view engaging us are assuredly of great delicacy. Effects are necessarily confounded with variations resulting from other atmospheric perturbations, and it is only on days of great calm that they can be made with effect. One would also have to be as near as possible to the equator, where calms are more frequent and the moon exerts its fullest power. Experiments of this kind have, as we are aware, been made there, though apparently without much result. Perhaps sufficient attention was not given to the essential points. In any case, there is reason to ask whether the flux and reflux of the masses of air disturbed might not be another cause of difficulties. Consequently, it would be so much the more difficult to obtain a positive solution.

The Value of the Barometer.

Whatever the action of atmospheric tides on the barometer, it is certain that the instrument, under the influence of currents produced, gives indications of incontestable utility to all those who study the weather. One can always draw probable conclusions which in most cases are realised. Sometimes forecasts of fine or foul weather prove illusive, or partially so. This is because changes have taken place in the currents upon which they were founded. Often enough, also, it rains without any wind, and generally in such cases the rain lasts longest. Yet the barometer is and remains low.

We may be sure that when the wind does not blow below, it does so above, and that the higher strata have been, and are, agitated. Rains, which follow violent winds after they have ceased, have an analogous origin. A higher current has certainly taken the place of that which has died out. These circumstances clearly demonstrate that the greater or less degree of dryness or humidity in the atmosphere has only a secondary influence on the barometer. The water-saturated strata which gives us rain have naturally a different density to the others. It is by depressions that they are recorded on the barometric column. Is not the evidence of another action absolute? We also meet with it in the opposite case with dry strata, less dense, which bring fine weather and can of themselves only determine depressions. As regards rain in calm weather or after more or less violent winds, the phenomenon might be explained by

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the action of the higher currents on those immediately below, where they cause condensations. Precipitations would be the more abundant, and saturation equal, as pressure decreased and the active current gained velocity.

Telegraphy in Meteoric Calculations.

Is the barometer the only instrument which can give us information respecting the weather? At the present day telegraph wires are proposed as an auxiliary, particular significations being ascribed to their vibrations. Such wires are acted upon by many causes. They could not tell us the action of currents in the heights of the atmosphere, from whence the disturbances are propagated which the barometer so faithfully translates.

The Effect of Tides.

The ocean tides which we mentioned in our argument lead us to another question, though of a different order. Basing his opinion upon observations of ancient eclipses of the moon, Delaunay maintained that the earth undergoes a slight abatement in its rotary motion, the cause of which he ascribed to friction of the tides against the continents. No doubt tides must have some such effect. However, it is evidently not to such an action that falling-off in speed of rotation is to be attributed. The tides dashed against the continents in former ages as they now do, and most have had the same effect. There is a more likely cause, to which thought has not been given. The globe accelerates its progress, at the perihelion, in its double motion of rotation and translation. This is one of the consequences of eccentricity of its orbit. Now this eccentricity decreases, and must continue to do so for more than twenty thousand years to attain the minimum to which it tends, and it is to this action that decrease in rotary speed must be attributed. What the earth loses at the perihelion it only partially regains at the other side, and the middle is necessarily affected. As for tides, far from acting with greater force at the present day, they must be feebler. Less agitated by attractions, they can but lose power, and their action grows so much the less. Consequently, instead of decreasing the rotary velocity, they would cause slackening. This, though not an important point, deserved mention. A final word about the barometer.

Depressions which are only the consequence of the velocity of the aërial currents are the more marked according as this velocity augments. Thus it can be ascertained simply by reading the instrument. Proportions would have to be calculated, which could be done possibly without very great difficulty. We wished to draw attention to this point. Let us add that by comparison of the speed of the wind below and the readings of the barometer we can estimate what it is above with some degree of certainty.

When the force of the wind is less than the depression recorded, we may conclude that the current is swifter in the higher regions. When it is greater it is a sign that the current above has not such velocity. This will be particularly useful in balloon ascents.

Specially Translated from the "Revue Scientifique."

Artificial Leather.

AMONG other curious novelties, which from time to time come to the fore, may be noted one recently patented by a French manufacturer. The waste portions of untanned skins and hides, are, by this process, converted into a most useful material. Having been already limed, the scraps are subjected to a further liming process, and are then washed and cut into small pieces. The material is then ground, being simultaneously sprayed with cold water, and after this the fibres are flattened out by treatment beneath the heavy runners of a mortar mill. Colouring-matters may be added during this process. The paste is treated with a solution of zinc sulphate or other sulphate to which formol may be added; it is spread out on cloths or moulded into blocks, and is dried (preferably *in vacuo*) and subjected to pressure. Skins which have not been limed are treated in this way for the preparation of sole leather. Friction rollers, toothed wheels, polishing wheels, pulleys or cones, etc., may be manufactured from the moulded paste. The removal of the water from the moulded blocks may be facilitated by piercing each block and supporting it on a rapidly-revolving spindle, this treatment forcing the water to the periphery by centrifugal force. When the leather is to be manufactured into sheets, belts, or bands, the pounded paste may be treated with a bath of alcohol or lactic acid. It is then spread between two cloths and rolled between heated cylinders. Sheets may thus be prepared for the bottoms and backs of seats, or for tapestry panels or covers, the surface being embossed as desired. The sheets may be cut up for use in electric apparatus for insulating purposes. The material resembles old oak in its working qualities, and can be planed, tapped, polished, etc., and will hold the threads of screws firmly. Sheets may be pasted together when objects of considerable thickness are required. The material may be coated or covered with an oil varnish, or may be impregnated with paraffin in a vacuum apparatus. In addition to the materials mentioned above, glucose and lanoline may be employed to impart suppleness and impermeability to the composition.

The Rôle of the Earth in Wireless Telegraphy.

AFTER the account of the disturbances caused in telegraphic communications by the magnetic storm on October 31 it would be desirable to ascertain its influence on wireless telegraphy; but whether it is considered useless to mention the subject or the yet rare employment of this mode of communication did not give an opportunity to make observations, we hear nothing of the matter. The interest of special observations would be the more interesting as the most varied hypotheses have been made respecting the rôle of the earth in this style of transmission. Initially, says the *Revue Générale des Sciences*, an important part was ascribed to the earth upon which all appliances were carefully placed. As, however, the Braun system demonstrated the apparent uselessness of contact with the earth, the majority of experimenters adopted views diametrically opposite, considering the transmission of electric waves analogous to that of light. The fact that the curve of the earth is an obstacle of so slight consequence was, it is true, quite an enigma. The difficulty of answering the question is so much greater as even in the Braun system co-operation of the soil cannot be entirely dispensed with. On the other hand, the altitudes attained in study of this problem were too slight in comparison with dimensions of the earth.

With the object of finding at least a partial solution of the question Mr. Koepsel endeavoured recently to demonstrate that the effects exerted on the earth by an ordinary transmitter are such that its electric potential is influenced to a remarkable degree so as to act on the receiver. He explained that the earth possesses a potential of not excessive extent. In fact, its value is given by the radius of the earth to wit, $6{\cdot}37 \times 10$ centimètres $= 708$ microfarads. Mr. Koepsel gave a theoretic proof of the possibility of producing an appreciable disturbance in potential of such a sphere with the limited resources of modern wireless telegraphy, the oscillations attaining as much as one volt.

In the event of this theory being correct, the Marconi transatlantic telegraphy would be terrestrial.—*Cosmos*, Nov. 14, 1903.

Mongoloid Europeans.

A CAREFUL consideration of the relics of the cave-men of Europe has led Professor Boyd Dawkins to the conclusion that the Eskimos of to-day are their representatives, and that the connection between these two peoples must be one of blood. He is, however, of opinion that the Eskimo type is extinct in Europe. Dr. Beddoe, on the other hand, is of opinion that there are possible traces of mongoloid races in the people of Wales and the West of England. While stating that the cave-men of Eurasia were driven eastward into North America, where their descendants now exist as Eskimos, Professor Boyd Dawkins points out that North-Eastern Siberia yet retains an Eskimo population—the Chukches. There are seventeenth-century records of a people inhabiting the Yulmal Peninsula who not only closely resembled the modern Eskimos in appearance and customs, but made use of their peculiar skin-covered skiff or kayak. These skin canoes have been unknown in Arctic Europe for the last few centuries, but they are said to have been used in the Orkneys as late as the beginning of the last century by a race of occasional visitors locally called "Finnmen." Popular tradition in the Orkneys has many references to these strangers, Finns or Lapps, as is the Norse meaning of the word, who frequently intermarried with the islanders, thus accounting for certain mongolian characteristics noted by Dr. Beddoe among the Shetlanders. The skin canoe has died out among modern Lapps, but the tradition of their use among their forefathers survives. If this tradition is accurate, it is reasonable to suppose that remnants of Lapps lingered among the fiords long after the "Norse" invasion from the Continent, and crossed from Scandinavia to Orkney as recently as the seventeenth century. This conclusion supports Dr. Beddoe's belief that there is a mongoloid element among Western Europeans.

Arctic Foxes.

THERE is a widespread, but erroneous, belief that the Arctic fox, while elsewhere assuming a white winter coat, in Iceland remains blue. The truth is that the Arctic fox turns white in the winter in Iceland as it does everywhere else, though, as a matter of fact, there is a greater proportion of blue winter forms to white than elsewhere in the Arctic regions. Horrebow, writing on this subject about a hundred and fifty years ago, expressed the opinion that the white and blue forms were two distinct varieties, as he had seen white foxes in the summer and the white colour is not invariably changed for the summer hue. There is, however, plenty of evidence to the contrary from those who have observed these animals in their transitional stage at the moulting season.

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Age and Altitudes.

NUMEROUS accidents occur every year to mountaineers, over which the Press makes a great fuss. But, says Mr. Zangger, of Zurich, it might be well to point out how much more numerous are deaths which shorten the days of people who have not made any ascent at all. There are people who spend their holidays in the Alps, and choose some place where they may lead a quiet, prudent life. And yet these persons die of the mountain, and they die much more of their quiet habit of life to which no publicity is given. This mortality is due simply to age, and people "of a certain age" should be warned of the danger they incur by living in these altitudes. The danger arises from the change which takes place in the circulatory system toward 50 years of age. The tension is augmented, and under the influence of barometric depression, congestion of the pulmonary vessels takes place with distension of the right ventricle of the heart. Hence arise the "*flanchements (?) du cœur*" which carry off so many. These fatalities are facilitated by the conditions, by the rapid changes of temperature, and by muscular activity. Thus it is particularly dangerous for those whose circulation is weak to take excessive exercise on a mountain. They should abstain from all walking, however little fatiguing, and even from those railways which make a rapid ascent or descent, for rapid changes of altitude are accompanied by rapid changes of atmospheric pressure, and these are bad for the circulation.

The "Westby" Series of Seascape Photographs.

(F. H. WORSLEY-BENISON, Chepstow.)

IT is really a pleasure to look upon one of these magnificent photographs, the representation of Nature by Nature's own hand. The mighty billows of the ocean dashing themselves to pieces against a rock-bound coast is an awe-inspiring sight, and one which one can watch for hours with wonder and admiration. Yet the subject is a difficult one for the artist to depict, the ever-changeful form of the waves prohibiting an exact portrayal of the existing details. It is then most interesting to have an artistic representation as well as a scientifically correct record to keep before us, and this splendid series, which includes many varieties of sea and land views, seems to approach the acme of perfection, and should prove of the greatest value both to the artist and to the student of Nature.

REVIEWS OF BOOKS.

The Decennial Publications of the University of Chicago:

Physical Chemistry in the Service of the Sciences. Professor Alexander Smith has done good service to the cause of Science in publishing an English version of the lectures on "Physical Chemistry in the Service of the Sciences," (University of Chicago Press), which were delivered by Professor Jacobus H. van 'T Hoff, at the Decennial Celebration of the University of Chicago. The lectures are dedicated by their author to Dr. William Rainey Harper, President of the University, who, with a talent for organisation which fills one with admiration, has within ten years called into existence a great university. Professor van 'T Hoff, who received the honorary degree of L.L.D., was one of the most prominent of the many distinguished Scientific men who visited the University on this occasion. He holds the Professorship of Physical Chemistry in the University of Berlin, and has brought to bear upon Chemical problems speculative and imaginative powers of the highest order. He originated the theory explaining the space relations of atoms in molecules, which has illumined the whole field of organic and inorganic matter; he is distinguished in dynamic chemistry; and is a brilliant discoverer in the field of the modern theory of solutions, a theory, which marks one of the greatest steps made by Chemistry in the last twenty years. The lectures were delivered in English, and are published in an only slightly condensed form,

Physical Chemistry in the Service of the Sciences, by Jacobus H. van 'T Hoff, Professor Ordinarius of the University of Berlin, Special Lecturer on Physical Chemistry. English version by Alexander Smith, of the Department of Chemistry in the University of Chicago. The Decennial Publications of the University of Chicago, Second Series, Vol. XVIII. 150 pp., cloth, royal 8vo; *net*, $1.50; post paid, $1.60. The University of Chicago Press, Chicago, Illinois.

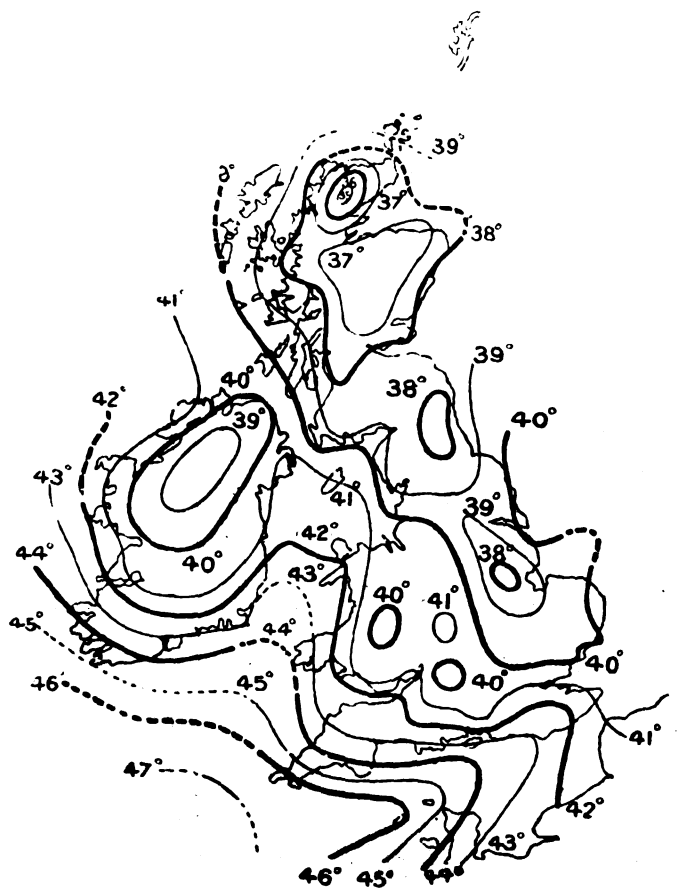
"Knowledge" Diary and Scientific Handbook, for 1904 ("Knowledge" office), again comes to the fore. The contents of the work is just the same as last year's edition with the exception of the insertion of a portrait of Darwin, and an article on "Practical Work with a Small Telescope," by E. Walter Maunder. Then follows the diary, with a full page for each day, and at the end of the book are articles on "The Camera Applied to Science," "Some Uses of the Microscope," "Numerical Apertures and Rapidity," and "Optical Contrasts of Lens Combinations."

H.M.S. "Triumph," late "Libertad."

THOSE interested in the construction of the two fine battleships which our Government has recently acquired from the Chilian naval authorities may be reminded that we had a complete account, accompanied by some interesting photographs specially lent to us, of the engines and hull of the *Libertad* (now *Triumph*) in the ILLUSTRATED SCIENTIFIC NEWS for April last.

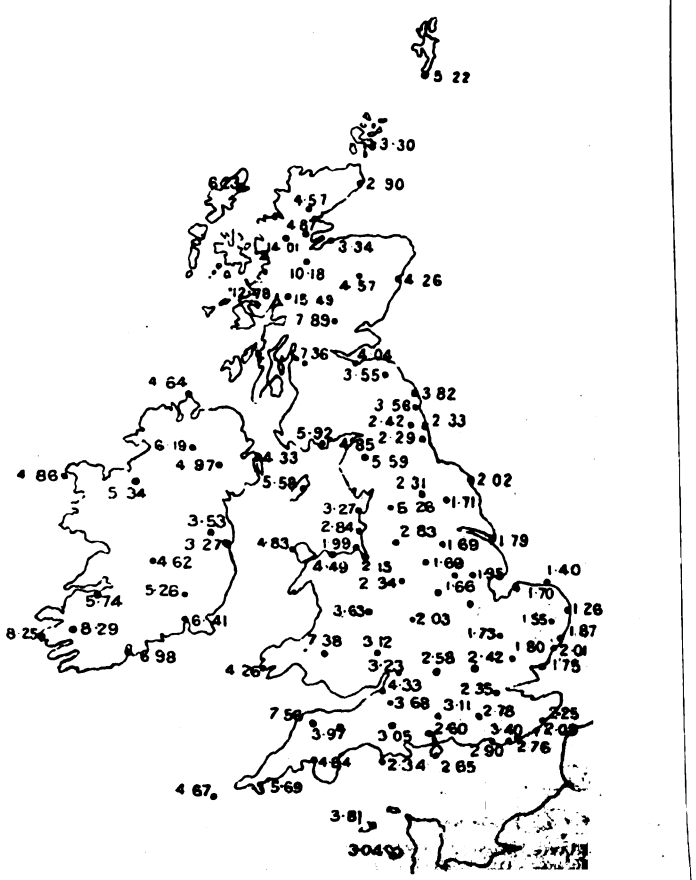
LAST YEAR'S WEATHER—JANUARY, 1903.

DISTRIBUTION OF MEAN TEMPERATURE.



The general distribution agreed very closely with the normal.

RAINFALL.



In excess of average, except in N.E. and central parts of England, where slight deficiency.

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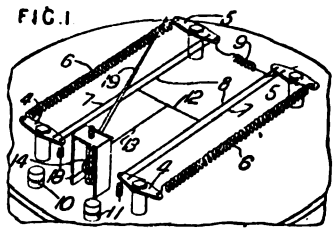
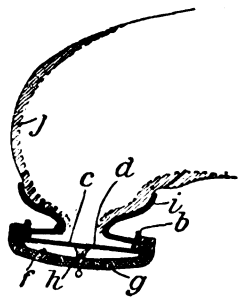
Recent Patents.

11,841. Electricity, measuring. LAKE, H. H., 45, Southampton Buildings, Middlesex.—(*General Electric Co.*; *Schenectady, New York, U.S.A.*) May 24.



Current meters.—A hot-wire ampere-meter or volt-meter is arranged as shown, in one form. Four wires 7, 8 are extended in pairs between four levers 4, 5, by means of springs 6. Two of the wires 7 are affected only by atmospheric temperature, and effect a compensation for its variations by moving the levers 4, 5. The other two wires 8 carry the current to be measured, through terminals 10, 11 and a connection 9; their middle points are connected together by a thread 12, the middle of which is attached to another thread 13. The latter thread is wound on a rotatable shaft 14, carrying a pointer 19 over a stationary scale, and acted on by a spiral spring 18, which tends to sag the first thread 12 and the conducting-wires 8. When these wires are heated by passage of current, they sag and allow deflection of the pointer by the spring 18. In modifications, pair of wires 7, 8 and levers may be replaced by a stationary attachment for one end of the thread 12, and the levers and springs 6 may be replaced by any other means for extending the wires.

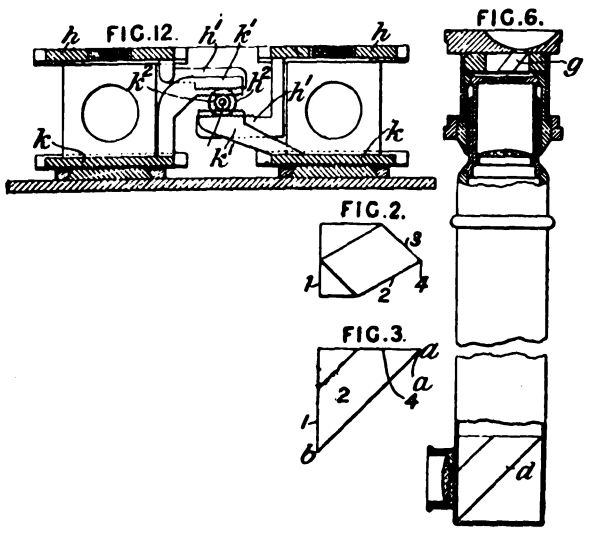
11,992. Phonographs, &c. BERNT, J., and CERVENKA, E., both of 34 Wassergasse, Prague, Bohemia, Austria. May 26.



The trumpet-holder *b* is formed with a cup *i*, into which the trumpet fits. The portion of the trumpet against which the waves from the diaphragm strike is covered with elastic non-metallic material *j*. The diaphragm *d* consists of wax or like plastic material on a backing of skin or fabric *c*. The bottom of the diaphragm is enclosed by the cap *f* covered with elastic material *g*. The style *h* projects through the cover. The Provisional Specification describes a method of producing records according to which the movements of a diaphragm are recorded photographically. It is stated that trumpets may be mounted on both sides of the reproducing-diaphragm.

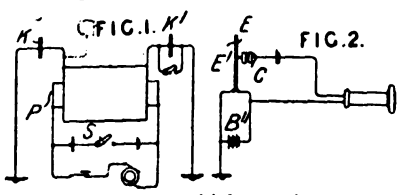
12,422. Telescopes. FORBES, G., 34, Great George Street, Westminster. May 31.

By the use of a special prism, an erect image is obtained, while the observer looks downwards into the telescope when held horizontally. The prism, shown in plan in Fig. 2, and side elevation, in Fig. 3, has a vertical entrant face 1, horizontal exit face 4, and two internal-reflection faces 2, 3 at right-angles to each other and having their common edge *a b* at 45° to the faces 1, 4. The prism may be placed immediately behind the object glass, as at *d* in Fig. 6, or at the principal focus, or between the field and eye lenses of the eye-piece. In a binocular of the form shown in Fig. 6, the distance between the eyes is accommodated by the use of a rhomboidal prism *g*, which diverts the rays into a parallel non-axial path. By



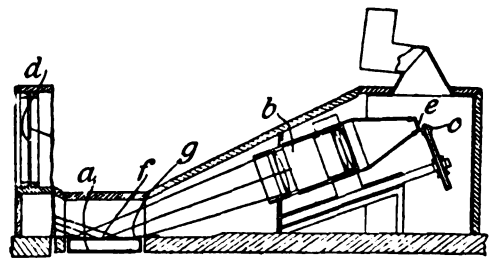
oppositely rotating the eccentric eye cups carrying the two prisms *g*, the distance between the paths of the rays from the two telescopes is varied. With the form of telescope in which the erecting prism is placed between the field and eye lenses of the eye-piece, it is necessary to move the eye lenses through double the distance moved by the erecting-prisms. Fig. 12 shows the arrangement employed. The prisms are mounted on slides *k*, *k*, fitted with racks k^1, k^1 gearing with the pinion k^2, while the eye lenses are carried by slides *h*, *h* having racks h^1, h^1 gearing with a pinion k^2 of double the size and mounted on the same shaft as the pinion k^2.

12,474. Wireless signalling. SHOEMAKER, H., 827, Arch Street, Philadelphia, Pennsylvania, U.S.A. May 31.



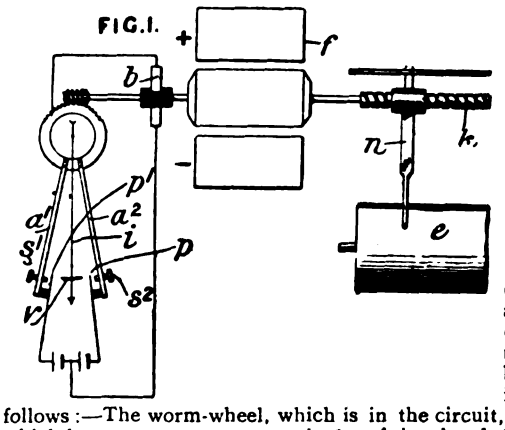
Relates to a system of wireless telegraphy or telephony. Fig. 1 shows a transmitting-station with one or more condensers K, K^1 connected in the earth or aërial branches of the secondary of the transformer PS, the transmitter and receiver being arranged in parallel circuits across the primary. Fig. 2 shows the receiver system, in which two juxtaposed plates E, E^1 are connected by a high-potential battery B^{11}; one of them E^1 is fixed, and the other is free to vibrate and is connected to a microphone C in a local receiving-circuit. Two microphones may be arranged in series or in parallel with two pairs of plates. In a modified form, the free plate may be connected through a tuned diaphragm with a contact-lever controlling the circuit of a relay operating a receiver.

12,446. Vibration recorders. MIDDLETON, P. C., and SMITH, W. S. H., both of Limes Road, Croydon, Surrey, May 31.



Vibrations, particularly those produced in buildings by motors, machinery, and the like, are transmitted to a horizontal surface of mercury, and indicated by the indistinctness of an image formed by convergent rays of light which have been reflected by the mercury. Rays from a source of light *c* pass through the stop *e* and an adjustable converging combination of lenses *b*. They are reflected at the surface of the mercury *f*, and come to a focus at *d*, either upon a screen or moving sensitized paper which forms a record. The interior surface of the vessel *a* is of some substance to which mercury does not adhere, and a mask *g* is preferably provided to keep the reflection central. When the apparatus is indicating the vibrations of gases, a diaphragm is suitably connected with the mercury.

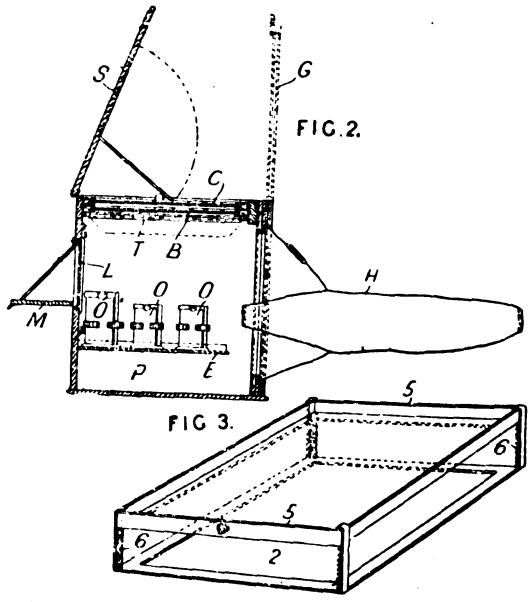
12,469. Recording-apparatus. WESTON, E., 645, High Street, Newark, and BENECKE, A. O., 19, Arlington Avenue, Vailsburg, both in New Jersey, U.S.A. May 31.



Registering observations by instruments, as for instance pressure gauges, tide gauges, wind vanes, water-level indicators, barometers, magnetic compasses, thermometers, and thermostats. The movements of the index hand *i* put in circuit with a divided battery *b* a small electromotor *f*, which turns a screw *k* and so shifts a tracing-nut along a revolving record drum *e*. In a modification, the screw is driven by a weight acting through one or other of a pair of electromagnetic clutches circuited by the index. The circuit is made and broken as follows:—The worm-wheel, which is in the circuit, carries a pair of arms a^1, a^2, which bear on screw contacts s^1, s^2 and insulated flexible contacts *p*, p^1. The index hand, not in the circuit, is provided with a cross-pin *v*, to press the flexible contacts against the screws. In modifications (1) the index hand is in the circuit, and the screw contacts replace the flexible contacts; (2) resistances are employed with an undivided battery.

Registering at a distance electrically.—The electromotor and recorder may be at a distance, another electromotor being used to drive the switch as above.

13,189. Photography. LAMBERT, J., 9, Westmoreland Road, Southport, Lancashire. June 10.



Dark boxes.—Relates to a portable dark box for changing, developing, and fixing, &c., plates. The box is shown in section in Fig. 2. The box is fitted with non-actinic windows B, C, and L, and the hands are inserted through sleeves H to manipulate the plates. Vessels O containing developers, &c., are placed at one end of a shelf E, on which the developing-dish is supported, the fixing-bath being placed at P underneath the shelf. A lamp may be placed on the shelf M. When not in use the windows are closed by shutters G, S, and M. The developing-dish 5, Fig. 3, is a shallow transparent dish, supported on springs 6 in a frame having a reflector 2, which throws the light up through the bottom of the dish. The dark box is fitted with supply and waste pipes for admitting and running off liquids. When packed up, the fixing-bath is fixed at T under the windows B, C.

The £100 Prize Competition.

THE awarding of the Grand Prize for the greatest number of marks obtained in the twelve competitions has now been decided upon.

"KASS" having obtained a total of 874 would have been first, but of these marks 50 were liable to be deducted, the solution having been sent in too late.

"Mephisto" being next with 840 would therefore be entitled to the prize.

The Proprietor has decided that the prize shall be divided as follows:—

£75 to "Mephisto," C. Leslie Walker, 29, Ludgate Hill, E.C.;

£25 to "Kass," W. Cassels Brown, 9, Manor St., Berkhampsted,

and cheques for these amounts have accordingly been sent.

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The British Association.

THE annual meeting of the British Association for the Advancement of Science took place this year at Belfast, under the presidency of Professor James Dewar, M.A., LL.D., D.Sc., F.R.S., commencing on the 12th September, and closing on the 17th.

There were, as usual, a great number of interesting papers brought before it, quite too many to publish *in extenso* in a periodical like this. To present even a satisfactory *résumé* of such a mass of instructive matter is most difficult, and it can but relate some of the most salient features of the various addresses, sufficient, we hope, to enable those wishing for further information to know where to seek it.

Address by the President.

Professor James Dewar, whose address was of more than usual interest on account of taking as his theme that fascinating, and it may almost be said novel, subject, researches in extreme cold.

After making timely references to His Majesty's Coronation, to the losses sustained to Science by the death of several remarkable men, and to the progress of Belfast since the last meeting, when Tyndall presided over the Association, Professor Dewar quoted some interesting facts and figures relative to the ENDOWMENT OF EDUCATION in this and other countries. As an instance he quotes how, in Germany, there were 4,500 trained chemists, whereas a liberal estimate for England would put the number at 1,500 to 2,000. Moreover we cannot be said to make up in quality what we lose in quantity, since 84 per cent. of the chemists employed in German works have received a thorough chemical training, whereas of a nearly similar number in British works only 31 per cent. have been systematically trained. The chemical industries in Germany have received enormous expansion during the last 30 years, their value being estimated at not less than £50,000,000 per annum, and the German manufacturers, having a practical monopoly, are able to exact huge profits. The fundamental discoveries upon which this gigantic industry is built were made in this country, but in spite of all things Englishmen have been driven out of the field. The cause of this Professor Dewar puts to want of education. We had the material in abundance, we had the capital, and we had the brains, but we did not possess the diffused education without which the ideas of men of genius cannot fructify beyond the limited scope of an individual. The patent laws are also partially to blame, but the chief cause is the want of education among our so-called educated classes, and secondarily among the workmen on whom they depend.

Professor Dewar then proceeded to give an outline of the history of research in COLD AND THE ABSOLUTE ZERO, quoting Bacon, who said, "The production of cold is a thing very worthy of the inquisition both for the use and the disclosure of causes. For heat and cold are Nature's two hands whereby she chiefly worketh, and heat we have in readiness in respect of the fire." Boyle, over 200 years ago, was the first to publish results of experiments in the subject. He used a mixture of snow or ice and salt, and was thereby able to show that water in becoming ice expands by one-ninth of its volume, and other important results. Amontons, in 1702, contributed valuable papers on the subject, as did Black, Gay-Lussac, and others later on. Lord Kelvin, in 1848, drew attention to an absolute method of temperature measurement completely independent of the properties of any particular substance (such as water). The zero of the new scale was taken to be such a temperature that the perfect engine should give an amount of work equal to the full mechanical equivalent of heat taken up. This led to a zero of 273 degrees centigrade below the temperature of freezing water being decided upon.

As regards the LIQUEFACTION OF GASES, it was Thilorier, who, in 1835, produced liquid carbonic acid, and further made the fortunate discovery that the liquid could be frozen into a snow by its own evaporation. Faraday was prompt to take advantage of this new and potent agent, and by combining this low temperature with pressure all the gases, except hydrogen, nitrogen, and oxygen and three compound gases, were liquefied by the year 1844. Andrews, James Thomson, and Van der Waals furthered the subject, and in 1883 Wroblewski liquefied oxygen. The liquefaction of oxygen and air was achieved through the use of liquid ethylene as a cooling agent, but from this time liquid oxygen and air came to be regarded as the potential cooling agents for future research, commanding as they did a temperature of 200 degrees below melting ice. The difficulty of attaining lower temperatures increases in geometrical rather than arithmetical ratio. Its magnitude may be estimated from the fact that to produce liquid air in the atmosphere of an ordinary laboratory is a feat analogous to the production of liquid water starting from steam at a white heat, working with all the implements and surroundings at the same high temperature. But the problem was not so much how to produce intense cold as how to save it when produced. Ordinary non-conducting packings were inadmissible because they are both cumbrous and opaque, and it is essential that the product should be visible. In 1892 Professor Dewar tried the effect of keeping liquefied gases in vessels having a double wall, the annular space between being very highly exhausted. It was found that when the inner walls were coated with a bright deposit of silver the influx of heat was diminished to one-sixth the amount entering without the metallic coating. The total effect of the high vacuum and the silvering is to reduce the ingoing heat to about 3 per cent. The efficiency of such vessels depends upon getting as high a vacuum as possible, and cold is one of the best means of effecting the desired exhaustion. All that is necessary is to fill completely the space that has to be exhausted with an easily condensible vapour, and then to freeze it out in a receptacle attached to the primary vessel that can be sealed off. The advantage of this method is that no air-pump is required, and that, theoretically, there is no limit to the degree of exhaustion that can be obtained. With hydrogen and other gases requiring great cold the process is simple, since liquid hydrogen, collected in such vessels with the annular space full of air, immediately solidifies the air, and thereby surrounds itself with a high vacuum. In the same way, when it shall be possible to collect a liquid boiling on the absolute scale at about 5°, as compared with the 20° of hydrogen, then you might have the annular space filled with the latter gas to begin with, and yet get directly a very high vacuum, owing to the solidification of the hydrogen. Many combinations of vacuum vessels can be arranged, and the lower the temperature at which we have to operate the more useful they become. Vessels of this kind are now in general use, and in them liquid air has crossed the American continent. What is known as the Kelvin-Joule effect, that is that compressed gases passing through a porous plug or small aperture were lowered in temperature, does not apply to hydrogen, depending as it does upon the absolute temperature. As regards the production of liquid air, M. Claude, of Paris, has succeeded in working a machine so efficiently as to produce one litre of liquid air per horse power expended per hour.

LIQUID HYDROGEN is a substance of especial interest, because the properties of hydrogen led the great chemists of former times to believe that in its solid state it would reveal metallic characters. The only way to arrive at the truth was to prosecute low-temperature research until its liquefaction would be produced. This was definitely accomplished by Professor Dewar in 1898. Liquid hydrogen proved to be a colourless transparent body of extraordinary intrinsic interest. It has a clearly defined surface, is easily seen, drops well, in spite of the fact that its surface tension is only the thirty-fifth part of that of water, or about one-fifth that of liquid air, and can be poured easily from vessel to vessel. The liquid does not conduct electricity, and, if anything, is slightly diamagnetic. Compared with an equal volume of liquid air, it requires only one-fifth the quantity of heat for vaporisation; on the other hand, its specific heat is 10 times that of liquid air or five times that of water. The coefficient of expansion of the fluid is remarkable, being about 10 times that of gas; it is by far the lightest liquid known to exist, its density being only one-fourteenth that of water: the lightest liquid previously known was liquid marsh gas, which is six times heavier. The only solid which has so small density as to float upon its surface is a piece of pith wood. It is by far the coldest liquid known. At ordinary atmospheric pressure it boils at *minus* 252.5° or 20.5° absolute. The critical point of the liquid is about 29° absolute, and the critical pressure not more than 15 atmospheres. The vapour of the hydrogen arising from the liquid was nearly the density of air—that is, it is 14 times that of the gas at the ordinary temperature. Reduction of the pressure by an airpump brings down the temperature to *minus* 258°, when the liquid becomes a solid resembling frozen foam, and this by further exhaustion is cooled to *minus* 260°, or 13° absolute, which is the lowest steady temperature that has been reached. The solid may also be got in the form of a clear transparent ice, melting at about 15° absolute, under a pressure of 55mm., possessing the unique density of one-eleventh that of water. Such cold involves the solidification of every gaseous substance but one that is at present definitely known to the chemist, and so liquid hydrogen introduces the investigator to a world of solid bodies. The contrast between this refrigerating substance and liquid air is most remarkable. On the removal of the loose plug of cotton-wool used to cover the mouth of the vacuum vessel in which it is stored, the action is followed by a miniature snowstorm of solid air, formed by the freezing of the atmosphere at the point where it comes into contact with the cold vapour rising from the liquid. This solid air falls into the vessel and accumulates as a white snow at the bottom of the liquid hydrogen.

Another important application of liquid gases is as analytic agents. Thus, if a gaseous mixture be cooled by means of liquid oxygen, only those constituents will be left in the gaseous state which are less condensable than oxygen, and if the gaseous residue be then cooled in liquid hydrogen a still further separation will be effected. By proceeding in this fashion it has been found possible to isolate helium from a mixture of gases. By the evaporation of solid hydrogen under the air-pump we can reach within 13 or 14 degrees of the zero. But to annihilate this gap of 13 degrees would be a far greater achievement than any so far accomplished, for the methods used become continually harder as the temperature is reduced. That the zero will ever be reached by man is extremely improbable. Many changes in the properties of substances have been found to vary steadily with the degree of cold. A series of experiments with pure metals showed that their electrical resistance gradually decreases as they are cooled to lower

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and lower temperatures, in such ratio that it appeared probable that at the zero of absolute temperature they would have no resistance at all and would become perfect conductors of electricity. This was the inference that seemed justifiable by observations taken at depths of cold which can be obtained by means of liquid air and less powerful refrigerants. But with the advent of the more powerful refrigerant liquid hydrogen it became necessary to revise that conclusion, and it is found that at very low temperatures the decrease is not in the same proportion.

The next step towards the absolute zero is to find another gas more volatile than hydrogen, and that we possess in HELIUM. This gas shows no signs of liquefaction even when compressed to 80 atmospheres while the tube containing it was surrounded with solid hydrogen. Further, on suddenly expanding, no instantaneous mist appeared. It is anticipated that the boiling-point of the liquid will be about 5 degrees absolute. As the liquid refractivity for hydrogen, oxygen, and nitrogen are closely proportional to the gaseous values, and as helium has only one-fourth the refractivity of hydrogen we must infer that liquid helium will be one-fourth that of liquid hydrogen. This means that the liquid will be quite exceptional in its optical properties, and very difficult to see.

Referring to the cold of space and of the UPPER AIR, Professor Dewar pictured the state of the earth when cooled to such an extent that the present ocean was frozen solid, and a new ocean of liquid air existed, covering the surface to a depth of 35 feet New light is thrown on the constitution of the aurora by experiments of passing electric discharges through the more volatile gases, which then glow with a bright orange light.

Though samples of air taken at an elevation of nine miles have shown no difference in composition from that at the ground, where hydrogen is present only in minute quantities, yet there is reason to suppose that a sample procured at a height of 37 miles would be found to contain 12 per cent. of hydrogen, while carbonic acid would practically disappear. At 47 miles, where the temperature is *minus* 132 degrees, the nitrogen and oxygen have so thinned out that the only constituent of the upper air which is left is hydrogen. The probable reason of the uniformity of the composition of the air at lower altitudes is because of the winds which stir it about. The existence of an atmosphere at more than a hundred miles above the surface of the earth is revealed to us by the appearance of meteors. Observations of the spectre of auroras show that a large number of the rays indentified are the same as those emitted by the most volatile gases at the temperature of liquid hydrogen. The rosy tint often seen in auroras appears to be due mainly to neon. The Swedish North Polar Expedition concluded from a number of trigonometrical measurements that the average above the ground of the base of the aurora was 34 miles.

The spectrum of the corona of the sun also shows the presence of the most volatile gases. The cause of the electric discharge which is believed to occasion the auroras may also be surmised as well as the appearances presented by comets.

Low-temperature researches also show other interesting facts. The force of cohesion is greatly increased at low temperatures, as is shown by the additional stress required to rupture metallic wires. The photographic action of light is diminished at the temperature of liquid air to about 20 per cent. of its ordinary efficiency. At these temperatures many organic and inorganic bodies acquire the property of phosphorescence. They glow faintly so long as they are kept cold, but become exceedingly brilliant during the period when the temperature is rising. Investigations show that electric conductivity in metals varies almost inversely as the temperature down to *minus* 200°, but copper cooled to *minus* 253° still has resistance. In the case of alloys cold brings about a much smaller decrease in resistivity, and with carbon, glass, ebonite, etc., the resistivity steadily increases. Magnetism and diamagnetism seem to be increased with cold to a certain extent. Elaborate tests have been made regarding the effect of great cold on bacteria, but after being exposed to the temperature of liquid air (and even liquid hydrogen) for 20 hours their vitality was not affected. A similar persistence of life in seeds has been demonstrated.

A.—Mathematical & Physical Science.

The address of the President of this Section, Prof. John Purser, consisted mainly of a historical sketch of the Irish School of Mathematics. References were made to the many eminent men who may be included under this heading, Dr. Bartholomew Lloyd, Dr. Romney Robinson, the astronomer inventor of the cup anemometer; Dr. Humphrey Lloyd, who made so many valuable observations on terrestrial magnetism; Lord Rosse, who constructed the great telescope, and experienced such difficulty in forging and polishing the speculum of metal harder than steel, yet more brittle than glass, and with it made valuable observations on the spiral structure of nebulæ; Sir William Hamilton, who, whilst yet an undergraduate, was appointed to the Chair of Astronomy, who evolved many theories in mathematics and mechanics, including his quaternian calculus; James MacCullagh, who devoted his labours to the theory of light and to geometry; Jellatt, who devised instruments for determining the polarization of light; George Fitzgerald; Andrews; and James Thomson, who among many other investigations, gave an interesting explanation of the action of the water of a river flowing round a bend, showing that the friction of the bed caused an undercurrent which deposited detritus on the inner bank. Prof. Purser closed his remarks with the hope that others of their countrymen might be found not unworthy to follow these great men, since there never was a time when science stood more in need of these gifted ones, who combined charms of thought with imagination and hopeful courage.

Lord Rayleigh next read a paper dealing with the question of whether, when two elements are chemically combined, the resulting substance was exactly equal to the sum of the weights of the separate constituents. This law has generally been taken for granted, but direct inquiry had brought to light discrepancies greater than could be ascribed to mere errors of observation. Newton, and, later, Bessel, made experiments by substituting various materials as the bob of a pendulum, but no alteration in the time of vibration could be detected.

Prof. J. J. Thomson mentioned his experiments of a similar nature. As water, under sufficient pressure, could be squeezed through gold it seemed not impossible that gas might escape through glass. Prof. Shuster described a method of weighing a disc of lead with the surface alternately placed horizontally and vertically. Mr. Boys mentioned that the distance of the weight from the centre of the earth must be taken into consideration, and that two weights superpoised would not weigh the same as if placed side by side. A paper by Dr. Howard Barnes described experiments on the variation in the velocity of water with temperature.

Prof. Schuster then read a paper on meteorological observations, pointing out a certain vagueness which at present prevails in them. The question to be decided is as to how far events which happen simultaneously are connected with each other. Thus the connection between the moon and earthquakes, or between sunsets and rainfall require more careful consideration.

Prof. Schuster warned meteorologists against allowing themselves to be swallowed up in routine work. This is all very well for certain purposes, but, he concluded, "Before you observe, make sure that your observations will be useful, and will help to answer a definite question."

Mr. A. R. Hinks spoke on the nebula surrounding Nova Persei, discussing the various explanations which had been put forward as to its character. Dr. J. Roberts showed photographs of this region, and also of a nebula in Aquarius, which showed wisps of light remarkably similar to those of the Nova Persei nebula.

Dr. W. E. Wilson read a paper on a new form of bolometer, and also one on the search for a planet beyond the orbit of Neptune, the existence of which has been inferred by Prof. Forbes and others.

The Rev. A. L. Cortie read a paper on the connection between sun spots and terrestrial magnetism.

Dr. C. S. Myers gave an account of experiments with Galton's whistles for giving notes so high as to be inaudible to most ears. He showed that with certain variations of wind pressure the audibility might be increased.

Dr. Isaac Roberts exhibited and explained photographs of stars taken at his observatory at Crowborough, as demonstrating the evolution of stellar systems. The lecturer incidentally mentioned his belief that the stellar universe as we see it was but a part of, and probably only one unit, in the Cosmos, and that trustworthy data were being rapidly accumulated by which this would be demonstrated.

Mr. W. N. Shaw gave a paper on "Radiation in Meteorology," hoping that observers would make special observations on the effect of radiation upon thermometers exposed under different conditions as regards cloud.

Major S. G. Burrard, R.E., read a paper on the figure of the earth, showing how the deflection of the plumb line may cause discrepancies in determining latitude. Even the exact position of India on the globe was a matter of uncertainty within some seven seconds. Col. Clarke had suggested that the equator might not be circular, but slightly elliptical. The surface of the sea, even, was not level, being permanently attracted by the mass of mountains and continents just as it was temporarily by the moon producing tides.

Prof. J. Milne presented the report of the Seismological Committee, showing that seismographs of the same type had been established at 38 stations about the world. The seismic centres had been, as far as possible, grouped into separate regions—observations had shown that the districts in which large earthquakes originated were those in which it could be shown that the surface had been elevated, or that elevation was yet in progress.

A paper written by Lord Kelvin was presented on "Animal Thermostat," opening the much vexed question of why and how the human body was constantly kept at a temperature of about 98.4 deg. Fahr. This was especially difficult to account for when the external air was considerably above this temperature, and still more so if the atmosphere was so saturated with moisture that perspiration could not evaporate from the surface. He suggested that the superfluous heat must be carried off with the breath. More experiments were needed, and these might be carried out on healthy persons in hot baths.

Mr. Butler-Burke read a paper on investigations on the phenomena of luminosity by means of mechanical and hydrodynamical models. Luminosity appeared to be due to the collisions between the molecular groups which had acquired great velocity.

A paper by Lord Rayleigh on "Does Motion through the Ether cause Double Refraction?" described experiments showing that the earth's motion through ether did not operate to a minute degree in producing double refraction. Dr. Larmor read a paper on "The Application of the Method of Entropy to Radiant Energy."

Prof. Ernest Wilson described how magnetic detectors had given consistent results as a substitute for coherers in wireless telegraphy. One form of the instrument consisted of a ring of fine iron wire, the magnetism of which could be continually reversed by a local battery. A telephone connected to a coil wound on the ring was used to receive the minute transient electric currents produced, when another coil on the ring received the electric impulse from the distant transmitter. Using straight iron wires to support the coils, the author found that the effects were increased by submitting the specimen to pull and twist stress, and also by heating it to a temperature a little below that at which iron ceases to be a magnetisable substance.

Prof. H. H. Turner read a paper on "The Relative Apparent Motions of Bright and Faint Stars." There is evidence that the bright stars are increasing their right ascension by about a hundredth of a second per magnitude per year, as compared to faint stars.

Mr. S. A. Saunders called attention to possible changes on the surface of the moon, which might be ascribed to vegetation of a low type.

Mr. Hinks showed a remarkable series of photographs taken at the Yerkes Observatory. Some were taken with the great 40-inch refractor, others with a 24-inch reflector. With the former, nine times greater exposure was necessary, but the picture was six times larger, which was of great importance in photographing star clusters and nebulæ.

Mr. Hinks also read a paper on the uncertainty of our knowledge of the sun's distance, referred to elsewhere in our columns.

Mr. Glazebrook, director of the National Physical Laboratory, reported on the "Construction of Practical Standards for Electrical Measurements."

The report of the Committee on "The Investigation of the Upper Atmosphere by Means of Kites" was also presented. The apparatus was to be fixed at Crinan, south of Oban. The greatest heights to which the kites had ascended was 11,450 feet, the temperature gradient observed being about 2½ deg. Fahr. for every 1,000 feet ascent.

B.—Chemistry.

The President of the Section, Prof. Edward Divers, said, with reference to "The Atomic Theory without Hypothesis," I would impress upon you that, in spite of all that has been said and written about the atomic hypothesis in connection with chemistry, the atomic theory propounded by Dalton and adopted, implicitly at least, by all chemists, is not founded upon the metaphysical conception of material discontinuity, and is not explained or illuminated by it. If, indeed, chemistry is a science which rests upon the atomic hypothesis, and, therefore, would cease to exist in the form into which it has developed, should matter prove to be continuous and not discrete, nothing can be said against the view that it is a science of the minute. But I am sure there can be no one ready to maintain that, if the hypothesis of the atomic constitution of substances were an unfounded

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one, the atomic theory would have been a discovery of no great importance; and Dalton himself, instead of being the founder of the chemistry of to-day, would have been little more than the discoverer of the law of multiple proportions. The opinion that chemical theory should be developed without reference to the atomic hypothesis has indeed all along been held by many eminent chemists; but then the dilemma appears to have presented itself to them, that either the atomic hypothesis must be granted, or the atomic theory must be dispensed with, since it falls with the hypothesis. That dilemma I do not recognise, and the practice of chemists shows beyond doubt that it is always ignored. Investigators use the theory, whether they admit it or not; teachers of the science find it indispensable to their task, however much they may deprecate, and rightly so, unreserved acceptance of the atomic hypothesis as true. After going more deeply into the question of atomic theory, Dr. Divers referred to the fact that the notions of radical and atom are so intimately related as to be often used indifferently, the one for the other. The radical, ethylene, is always an atom of ethylene, the radical, nitrogen, always an atom of nitrogen. Radical and atom are in fact the qualitative and quantitative aspects of the same thing. They are thus exactly parallel with substance and molecule. He went further into the subject, and brought forward many new ideas in theoretical chemistry.

Prof. Letts read papers on the amount of carbonic anhydride absorbed from sea water by air, and one on the corrosion of copper by sea-water.

Prof. Frank Clowes described the action of distilled water on lead, proving from his experiments that dissolved oxygen was the cause of the action of water upon lead, and, further, that the presure of carbon dioxide exerted an inhibitory effect upon the action.

Dr. A. W. Crossley read a paper on "Hydro-aromatic Compounds."

Mr. Bertram Blount, in a paper on the "Standardization of Chemical Analysis," pointed out how standardization was applicable to certain processes, but not to others.

Dr. C. E. Fawsitt read a paper on the decomposition of urea in ammonia and carbonic anhydride. Prof. Noel Hartley presented the report of the committee on absorption spectra.

Mr. W. Ackroyd read a paper on the telluric distribution of the elements, showing that this distribution may be inversely as their atomic mass.

Dr. J. H. Gladstone presented a paper on "Colloids of Zirconium," and also one on "Fluorescent and Phosphorescent Diamonds," in which he said that only some diamonds seemed to have these properties—sometimes after exposure they fluoresced for a little while, but then lost their power, which, however, was recovered to a certain extent when they were kept in the dark for a year or so.

Prof. Letts, in a paper on "Absorption of Ammonia from Water by Algæ," showed that the sea-lettuce absorbed large quantities of nitrogenous constituents from sea-water, and might be of use as a scavenger in the purification of sewage.

C.—Geology.

Lieut.-General C. A. McMahon, the president of this section, spoke on "Some Aspects of Rock Metamorphism." Giving a short description of a granite in the Sutlej Valley of the Himalayas, which is an intruder in the normal gueissous granite, he traced its probable formation, referring to the fact that water under great pressure, at or above red heat, has a powerfully solvent action on most minerals, even on so refractory a mineral as quartz.

Prof. Granville Cole gave a lecture on the geology of the country around Belfast.

Mr. Joseph Wright read a paper on "Marine Fauna of the Boulder Clay." Microscopical examinations of samples from a number of different plans showed foraminifera referable to species at present living at moderate depths off our coasts.

Mr. R. J. Ussher read the report of the Committee appointed to explore Irish caves. It dealt with the Kesh caves in Sligo. Broken bones of domestic animals, and a few implements were found.

Mr. H. J. Seymour read a paper on "Minerals known to occur in Ireland," from which it appears that 115 species are now definitely known to occur, though much work still remains to be done before the subject can be considered as completed. Mr. R. Clark communicated a paper on "Fossils of the Silurian Area of North-East Ireland."

Mr. H. B. Woodward gave a short paper on "the occurrence of Bagshot beds near Lyme Regis," which were to be observed in the cutting of the new railway between Axminster and Lyme Regis.

Mr. J. Joly read a paper on the viscous fusion of rock-forming minerals. He explained that under the influence of prolonged exposure to high temperatures, signs of fusion could be obtained at much lower temperatures than had hitherto been assigned as the melting points. This was especially the case with minerals containing a large percentage of silica.

Mr. J. J. H. Teall explained the work of the Survey in Ireland, and Mr. Lamplugh described the features of the glacial drifts represented in the map of the Dublin area. Mr. H. Kynaston made some remarks on the volcanic rocks of Glencoe. Prof. H. G. Seeley read a paper on Fossils from the Salt Range of India.

The Rev. J. F. Blake advocated the theory of the formation of continental plateau by deposition rather than by erosion.

Mme. Christen read an account of investigations into the glacial drifts of the north-east of Ireland.

Mr. P. F. Kendall spoke of the brockrams of the Vale of Eden, and read the report of the Committee on the Erratic Blocks of the British Isles.

Dr. W. Mackie read a paper on the conditions under which manganese dioxide has been deposited in the sedimentary rocks.

Prof. Grenville Cole delivered a lecture on the Geological structure of Ireland, describing the formation of the various rocks. Mr. G. Barron described the similarity of rock formations in Scotland and Ireland.

Mr. E. A. Newell read a paper on the "Fossil Flora of the Cumberland Coal field," and Mr. R. Lloyd Praeger one on the Post Glacial Deposits of the Belfast District.

Prof. W. Watts read the report of the committee for the Collection of photographs of geological interest in the United Kingdom, stating that the total number now in the collection was 3,308, which are deposited in the Museum in Jermyn Street.

Mr. H. W. Monckton read a paper on "The Valleys at the Head of the Hardanger Fjord." Mr. A. R. Hunt gave one on the "Hydrothermal Metamorphism of the Schists of South Devon." Mr. A. Coomaraswamy explained some photographic views of the scenery of Ceylon. Mr. W. G. Fearnsides gave a paper on some new fossils from North Wales. Dr. A. Smith Woodward read one on "Carboniferous Fish Fauna from Victoria, Australia." Mr H. W. Monckton showed some lantern slides demonstrating the principal changes in S.E. England during Pliocene and more recent times.

D.—Zoology.

The presidential address, given by Prof. G. B. Howes, was on the "Morphological Method and its Progress." After reviewing the state of the science 28 years ago, when the Association last met at Belfast, he referred to its state at the present time. Of the 386,000 living animal species, to compute the estimate low, every one available has been laid under hand, with the result that our annual literary output now amounts to close upon 10,000 contributions, the description of new genera and sub-genera, say 1,700. Turning to Paleontology, without which our present extensive knowledge of Zoology would not have come about, Prof. Howes referred to the interest of discoveries in the Egyptian desert. Here there have recently been found the bones of a huge cetacean associated, as in South America, with those of a giant snake, one of the longest known, since it must have reached a length of 30ft. There also occur the remains of other snakes, of chelonians of remarkable adaptive type, of crocodilians, fishes, and other animals. Interest, however, is greatest concerning the Mammalia, which for novelty are quite up to the American standard, as with an upper and a lower jaw of an anomalous creature, concerning which we can only at present remark that it may be a marsupial, or more probably a carnivore, which has taken on the rodent type in a manner peculiarly its own. Important beyond this, however, are a series of Eocene forms, which more than fill a long-standing gap, viz., that of the ancestors of the elephants and mastodons, which hitherto stopped short in the Middle Miocene of both old and new worlds. So far as these remains are known, they appear to present in their combined characters all that the most ardent evolutionist could desire. There are with them mastodons which simplify our knowledge of this group; and among the last discovered remains Sirenians, which, in presenting a certain similarity to the afore-named Mæritherium, strengthen the belief in the proboscidian relationships of these aquatic forms. Finally, and most noticeable of all, there is the genus "Arsinoitherium," a heavy brute with an olfactory vacuity which outrivals that of "Grypotherium" itself, and is surmounted by a monstrous frontonasal horn, swollen and bifid, for which the most formidable among the Titanotheres might yearn in vain.

Prof. W. C. McIntosh communicated a paper on "British Fisheries Investigations," and the question of State assistance.

Mr. Walter Garstang, in the course of some remarks, said that legislation could not be commended with regard to the regulation of fisheries until a sound knowledge was obtained of the life conditions of the food-fishes. Comments were also made by Dr. H. R. Mill and by Dr. Noel Paton.

Mr. J. Stuart Thomson read a paper on "The scales of fishes as an index of age," and Dr. Hume Patterson on "The causes of Salmon disease."

Professor Herdman gave an account of his recent expedition to the Indian Ocean, collecting amphipods, copepods, and cuttle fishes.

Prof. Cleland described a new element in the occipital bone of seals.

Mr. J. Hume Patterson read an important paper on "Bacteriological investigations into the causes of salmon disease." He was able to show that the fungus Saprolegnia Ferax was not, as hitherto supposed, the cause of salmon disease; but, on the other hand, that bacilli broke down the tissues and thus prepared the way for the fungus. Abrasions to the skin were accountable for the disease, and these were caused by being knocked against rocks, or by the fish grovelling in the sand to lay its eggs.

Dr. Scharff spoke on the subject of the supposed ancient land of Atlantis, the legends connected with it being corroborated by the fact that living as well as extinct flora and fauna in Europe had a number of types in common with North America. He considered it most probable that a land existed connecting North Africa with Brazil. Mr. G. H. Carpenter read a paper on "The Insect Fauna of some Irish Caves."

Prof. Poulton opened an interesting discussion on "Natural Selection in relation to Protective Resemblance and Mimicry in Animals." Many animals and fish were darker in the upper parts, where the illumination was strongest, and lighter below where the illumination was weakest, thus tending to obliterate the effect of shadow.

Several speakers instanced the uncertainty of why some animals and insects copied others. Insects had many enemies to encounter, and by concealing themselves from some might lay themselves at the mercy of others.

E.—Geography.

Colonel Sir Thomas Holditch, the President of this Section, in his opening address, remarked how absolutely regrettable it was that the unknown world was so rapidly growing smaller, and how delightful the time of old when so much was to be achieved outside the area of known lands. Few blank spaces still existed on the map, the Polar regions forming the special domain of modern initial exploration. The unmapped continent at the south end of the world was now being investigated by four expeditions, the "Discovery" going towards Victoria Land; Otto Nordenskiold's expedition to Graham's Land; the Scottish expedition, under Bruce, almost on the Greenwich meridian; and the Germans pushing southwards about the meridian of 90 deg. E. He had but lately returned from parts associated in the memory of all geographers with the names of Charles Darwin and H.M.S. "Beagle." The charts of the South American coast to-day were those of the "Beagle." One of the great sins of omission in modern exploration was that of a failure to appreciate the efforts of preceding geographers, the want of a patient absorption of all available previous knowledge before they attempted to add to the sum of it. Sven Hedin spent three years in reading about Central Asia before he wrote a word on the subject. It was much more frequently want of time rather than want of inclination which prevented the acquisition of that preliminary and most essential knowledge. Taking in turn the various fields left for exploration, Sir T. Holditch mentioned Siberia, where the Russians had organised systems of exploration; Central and Southern Arabia, where there was still much to learn; in China and Siam there was more for the road and railway maker than for the irresponsible geographical traveller; but in the Central deserts of Mongolia and Tibet, and among the Himalayas, he might find untrodden areas, than which there was no more promising field still open to the bona-fide explorer. There were also other fields almost equally promising. Patagonia and Central South America, though the areas of unknown land are rapidly diminishing, are of the greatest commercial and political interest, because of its advance towards a leading position as the pastoral and meat producing quarter of the globe, with possibilities of development probably exceeding those of Australia, New Zealand, and South Africa all put together. Africa is now embraced by a perfect network of explorers' lines, which leave only intermediate spaces, if any room, for the enterprise of the pioneer. With reference to surveys of the land, reference was made to the Geodetic triangulation in North America and also in South Africa. But the latter was painfully slow in its progress, and not appealing to the imagination like an Antarctic expedition, although it might lead to far more solid results, was crippled for want of money. The danger of building up a puzzle map, of piling one on to another the results of local fiscal surveys in the hope that when put together they might make a good topographical guide to the country, had proved, in South Africa, disastrous from the scientific and from the military point of view. Telegraphs were now a very important adjunct in geographical survey. The establishment of a school of practical geography in England was much needed to educate topographers, though the progress of geographical education showed encouraging symptoms of vitality.

Major P. Molesworth Sykes, the first British Consul in Eastern Persia, read a paper dealing with the geography of Southern Persia. This is mostly a barren country, rising over ridges of mountains to the Iran plateau, and thence slopes down to the Lut, or great desert. The changing course of the rivers and artificial canals have at various times altered the character of districts. Careful inquiry had led the author to believe that the name Lut properly applied to the whole of the great desert of Persia, including the so-called Dasht-i-Kavir in the north and the Dasht-i-Lut in the south, and that its saline portions were known as Kavir, which was undoubtedly the Arabic word *kafr*, signifying a saline swamp. As regards the term Lut, the guides pointed out fantastic bluffs, resembling forts, mosques, or cathedrals, and explained how they were ruins of cities which the Almighty destroyed, as was the case with the cities of the plain, from which Lot escaped with so much difficulty. It would seem that this great waste of Persia had become associated (most appropriately) with the name of Lot, Abraham's nephew.

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The President emphasised the importance of keeping an eye on that part of the country, as a possible approach to India. A proposal had been made to construct a railway between Quetta and Nushki. A new telegraph line was also being made, but he wished to point out that the comparative difficulty of maintaining and protecting a line across country, as compared to one along the coast, which could also be looked after from a ship.

Capt. Ryder, R.E., then read a paper on Yun-nan, the most south-westerly province of China, which, though one of the largest, was one of the least populated. He was sent to this country to report on the possibility of running a railway line through it but considers that owing to its mountainous nature and its poor prospects of trade, such would be impracticable.

Mr. R. B. Buckley contributed a paper on "Colonisation and Irrigation in Uganda." The uplands of East Africa were most suitable for colonisation, and, if it could be irrigated, nearly all European crops and fruits could be grown there. But the possibilities of irrigation were not very hopeful.

Dr. T. N. Johnston communicated a paper on the survey of the Scottish freshwater lakes, incidentally referring to seiches, or oscillations, causing the level of the water in the lochs to vary with a more or less regular movement. The origin of these does not appear to be clear, but has been ascribed to barometric pressure, to action of the wind, or to tremors of the earth.

Dr. H. R. Mill gave an address on "Antarctic Expeditions," and was followed by Mr. W. S. Bruce, the leader of the Scottish National Antarctic Expedition. He said that few people had an idea of the immensity of the unknown area in the South Polar regions, which covered two and a half times the area of Europe. The four expeditions now at work in exploring these regions had each their own sphere. The work of the British and Germans was chiefly magnetical; that of the Swedes mainly geological; while in the Scottish expedition oceanography and meteorology were the main points. He then detailed the work before the Scottish explorers, and described their ship and apparatus.

Prof. Libbey, of the United States, gave a lecture entitled "With Lieut. Peary in Greenland," illustrated by lantern slides, and containing many interesting details of Arctic exploration.

F.—Economic Science and Statistics.

Mr. Edward Cannan, in his Presidenital address to this Section, said that there is no text-book of economics which commands any really wide approval, and that therefore he would sketch the course of instruction which the modern teacher of economic theory puts before those who come to him for instruction. He will try to open the eyes of his pupils to the wonderful way in which the people of the whole civilised world now co-operate in the production of wealth, and to consider the daily feeding of the millions of closely-packed Londoners, why some people are rich and others poor, and the functions of government. The wide-spread dissemination of such teaching would help to bring about desirable changes. It would show the advantages of international trade, and, amongst other things, throw light on the housing question in London, and on subsidies on means of conveyance, and with regard to international relations.

"The Localisation of Industry," by the Rev. Dr. Cunningham, suggested reasons for the establishment of certain industrial centres in particular localities. Mineral resources, water supply, good opportunities for trade, have their various effects. Physical conditions must always be an element, but the business capacity of some capitalist seems to be the main factor in the successful planting of trade in a particular place.

Mr. A. B. Clarke read a paper on "Economic History and Economic Theory," and Dr. W. R. Scott one on "The Position of Economics in University Training for Commercial Life."

Prof. W. Graham gave a paper on "Trusts, from the point of view of Economic Theory," Dr. B. W. Ginsburg one on "Shipping Combinations," and the Hon. R. Porter one on "Municipal Trading."

Mr. Bradbrook read a report on the economic effect of the Factory Acts, dealing with the work of women.

Sir R. Lloyd Patterson contributed a paper on "The Linen Industry of Ireland," which in 1899 was estimated to employ a capital of £12,000,000, tracing its whole history from the time of the Phœnicians to the present day.

Judge Shaw read a paper on "A British Zollverein," Mr. Benjamin Allen one on "The Effects on Ireland of Free Trade in the United Kingdom," Mr. J. H. Edgar one on the "Depopulation of Ireland: its causes and Economic Results," stating that in 1846 the population was over eight and a half millions, while now being not quite four and a half millions, and Prof. Gonner one on "The Population of England and Wales in the 18th Century."

Miss Hutchins, Miss Harrison, and Miss Blackburn read papers dealing with labour questions as they affect women.

Prof. Chapman read a paper on "The Regulation of Wages in Developed Industries," and Mr. R. Brown one dealing with the "Death-rates from Consumption," with special reference to Ireland, where it is said to be increasing. He puts it down chiefly to bad ventilation and unsuitable food.

G.—Engineering.

The President of the Engineering Section, Prof. John Perry, F.R.S., said, in the course of his address: The education of the engineer cannot do more than prepare the young man for the higher education which lasts throughout his career, for he has to use his own methods and cannot always be guided by rule of thumb. Great stress is now laid on Latin in school education, though it is but of little use in after-life. It is sufficient to teach a boy how to learn, and then let him learn for himself. In England the curse of all education is the small amount of money available for the wages of teachers. No right-thinking engineer has been scared by the newspaper writers who tell us of our loss of supremacy in manufacture, but I think that every engineer sees the necessity for reform in many of our ways, and especially in this of education.

Mr. Herbert A. Humphrey then read a paper on "Recent Progress in Large Gas-Engines," pointing out what great progress had been made during the last few years, a development which has but few parallels in the history of engineering enterprise. Gas-engines of 1,500 h.-p. were already working, and others up to 4,000 h.-p. were being constructed. Not only in England but on the Continent and in America was progress being made.

The Hon. C. A. Parsons gave an interesting paper on "Steam Turbines." The invention first developed for driving dynamos in 1884, and in 1890 some 360 machines were working, varying from 4 to 120 horse-power. The largest turbine made in England was 3,000 horse-power, but larger ones are being built. The steam turbine compared favourably in regard to economy with the ordinary steam engine in the generation of electricity. Seven vessels have been fitted with these engines, and several more were being fitted, including a destroyer, a third-class cruiser, and two cross-Channel boats of about 8,000 horse-power. The "King Edward," in one season's work, ran ten more miles, with a coal consumption of 480 tons less than a boat of similar dimensions and speed with ordinary engines. The author concluded by stating that the adoption of the steam turbine system in vessels of large size, such as Atlantic liners, cruisers, and battleships, would be attended with greater proportional advantages than in the case of smaller vessels. The large turbines would be cheaper to build, would be lighter, and would occupy less space in proportion to power. The design of such large turbines presented no difficulties beyond those already surmounted, and the greater size permitted the adoption of important features for the further reduction of coal consumption.

Prof. Hill Shaw read a report on "Road Traction," and Dr. H. R. Mill gave a paper on "Rainfall of Ireland," the average being about 42 inches.

Mr. J. E. Kingsbury dilated on "The Future of the Telephone in the United Kingdom," maintaining that competition was incompatible with efficiency.

Prof. E. Wilson spoke on "Alloys of Aluminium." Specimens of various alloys had been exposed to London atmosphere for thirteen months, and then tested. Corrosion increased with the percentage of copper.

Mr. W. J. Taylor read a paper on "The Science of the Workshop." After discussing the materials for making tools, reference was made to milling and punching. Small articles could be produced quickly, but large masses demanded the slow-acting hydraulic press. The author also dealt with the action of grinding machinery.

Mr. W. H. Booth read a paper on "Smokeless Combustion of Bituminous Fuel," showing that water-tube boilers, though usually so bad as smoke-producers, could easily be so set as not to produce smoke.

Mr. J. S. Raworth described a system of preventing the formation of smoke in a boiler furnace by injecting a mixture of air and nitrate of soda solution on to the fire.

Sir Fred. Bramwell referred to his experiences with various boilers, mentioning a strange carriage which ran, sixty-two years ago, with passengers between Paddington and Bow, and made no smoke, noise, or dirt.

Lieut.-Colonel Crompton described a type of American boiler, consisting of a series of flat coils containing very little water, superheated steam being delivered at a temperature of about 800 degs.

Prof. Forbes described his new range-finder, which is described elsewhere in this paper.

Mr. R. G. Allanson-Winn read a paper on the "Direction and Velocity of Material-Bearing Ocean Currents," which he considered a subject demanding more attention, and had therefore designed an instrument to show the direction and velocity of the currents. This consisted of a heavily-weighted vertical bar, on which rotated a vane—a compass was attached, and the compass and the vane were clamped in position when the weight was lifted off the bottom. A current meter was also attached.

H.—Anthropology.

Dr. A. C. Haddon, F.R.S., the President of the Section, chose "Totemism" as the subject of his address. This term, he explained, is often used somewhat wrongly, and should imply the division of a people into several totem kins, each of which has one, or more, totems. The totem, usually a species of animal or plant, is the crest or symbol of the clan. Totemism comes from North America, but is more pronounced in Australia, and partially so in Africa, and in parts of Asia. Dr. Haddon then discussed the curious customs prevailing in many countries of what he calls "demonism" and fetish. He considers totemism to be of very ancient origin and suggests that it is derived from the time when primitive man was divided into groups living in particular localities containing particular animals and plants. Totemism also involves the rule of exogamy, forbidding marriage within the kin.

The Rev. J. H. Holmes submitted two papers on the ceremonies of natives of the Papuan Gulf, describing how the native boys are kept in the *eravo* hut at the commencement of puberty, and kept there to learn the social customs, etc. The second paper dealt with the religious customs.

Prof. D. J. Cunningham read a paper on "Cornelius Magrath, the Irish Giant." His height was 7 feet 5 inches. Mr. W. J. Fennell read a paper on "Some Ulster Souterrains," the abodes of prehistoric man.

Mr. George Clinch described some ancient subterranean chambers recently discovered at Waddon, near Croydon. They were probably sepulchral.

Mr. D. MacRitchie also gave a paper on "Underground Dwellings in the British Isles."

The Hon. John Abercromby read a paper on the oldest bronze age ceramic type in Britain, proving its close analogy to that found on the Rhine and its probable origin in Central Europe.

Mr. W. J. Knowles read three papers, one on "Objects of the Plateau Kind" from the interglacial gravels of Ireland; one on some axe factories near Cushendall; and one on the manufacture of arrow and spear heads.

Mr. Arthur Evans communicated an interesting report on the excavations of the prehistoric Palace of Knossos in Crete. The ruins cover an area of about 5 acres, remains of rooms, halls, and even staircases having been found. A complete system of drainage was discovered, and a shrine with objects and idols in place, and paintings. Many other interesting finds were described.

Mr. E. S. Hartland gave a paper on the famous Stone of Destiny at Tara, showing that evidence was against the suggestion of its being identical with the Coronation Stone in Westminster Abbey.

Dr. C. S. Myers read the report of the committee for anthropometric investigation among the native troops of the Egyptian Army.

I.—Physiology.

The President of this Section, Prof. W. D. Halliburton, discussed the present position of chemical physiology. Bold experimentation and bold theorising from experimental data are of the great importance. He instanced the work of Ehrlich as typifying the useful part played by bold theorising, and the work of Pawlow that of experiment. The latter has succeeded in throwing an entirely new light on the processes of digestion, which was gone into, while Ehrlich's hypothesis deals with the power the blood possesses of slaying bacteria.

Prof. Schäfer read two papers, the first on the "Diuretic Action of Pituitary Extracts," and the second on the "Relative Effects of Section of the Pyramidal Trasts and Anterior Columns in the Monkey."

Dr. C. S. Myers spoke on the smallest perceptible musical tone difference among the people of the Torres Straits and of Scotland.

Dr. John Turner read a paper on some new features in the intimate structure of the human cerebral cortex.

The President, Prof. Halliburton, read an important paper on the "Regeneration of Nerves." The question of whether the nerve fibres sprouted out from the stump of the divided nerve, or that the new fibres had a peripheral origin, was discussed.

K.—Botany.

The President of this Section was Professor J. Reynolds Green, and took for his subject the "Field of Vegetable Physiology."

Papers were read by Prof. Bose, Mrs. D. H. Scott, Prof. J. R. Green, Prof. A. Macfadyen, Dr. Dixon, Mr. W. C. Worsdell, Mr. E. Lloyd Praeger, and others.

L.—Educational Science.

This section was presided over by Prof. H. Armstrong, who, in the course of his address, insisted that the existing system of education was defective in not paying proper attention to developing imaginative power, and declared that a complete reorganisation of Education Department was necessary.

Prof. Forsyth presented the report of the committee on the teaching of elementary mathematics. Sir F. Bramwell advocated the adoption of a universal language for all countries. Other papers were read by Dr. Starkie, Mr. W. M. Hiller, Mr. R. M. Jones, Mr. T. P. Gill, and many others.

At the final meeting of the General Committee, the President announced that the meeting next year would be held at Southport. Sir Norman Lockyer was elected President for 1904, when the meeting would be held at Cambridge.

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